# Artificial Propagation Evaluation Workshop Report

*April 21-23, 2004*


*National Marine Fisheries Service*
*Salmon Recovery and*
*Protected Resources Divisions*

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Summary:

As part of its Endangered Species Act (ESA) status review for 27 Evolutionarily Significant Units (ESUs) of Pacific salmon, the National Marine Fisheries Service (NMFS) convened an Artificial Propagation Evaluation Workshop in April of 2004, consisting of federal scientists and managers with expertise in salmonid artificial propagation,. The workshop was convened to evaluate the best available scientific and commercial information regarding artificial propagation (hatchery) programs to assess their contribution to the viability of an entire ESU. Twenty-three of the 27 ESUs under review include artificial propagation programs. In assessing the extinction risk of an ESU, NMFS considers the contribution of both naturally and hatchery produced components to the viability of the ESU in-total. To assess the viability of an ESU in-total, the workshop participants reviewed: the findings of NMFS' Biological Review Team's Final Report that evaluated the collective viability of the naturally spawning populations in an ESU; and evaluated NMFS' Salmonid Hatchery Inventory and Effects Evaluation Report that details the ESU membership of individual hatchery programs, and analyzes the effects of hatchery programs on the viability of populations and the likelihood of extinction of the subject ESUs.

This report describes the workshop discussions, as well as the workshop's conclusions regarding the extinction risk of 23 ESUs that include artificial propagation programs. The workshop concluded that four ESUs are "in danger of extinction throughout all or a significant portion of its range," and that 19 ESUs are "likely to become endangered in the foreseeable future throughout all or a significant portion of its range." Within-ESU artificial propagation programs substantially mitigated the immediacy of extinction risk for two ESUs (the Lower Columbia River coho and Upper Columbia River Oncorhynchus mykiss ESUs). Within-ESU artificial propagation programs did not substantially influence the risk of extinction for the remaining 21 ESUs.

# 1. Introduction

## 1.1 Listing Species Under the Endangered Species Act

NMFS is responsible for determining whether species, subspecies, or distinct population segments (DPSs) of Pacific salmon and steelhead are threatened or endangered under the Endangered Species Act (ESA) (16 U.S.C. 1531 et seq). To be considered for listing under the ESA, a group of organisms must constitute a "species," which is defined in section 3 of the ESA to include "any subspecies of fish or wildlife or plants, and any distinct population segment [emphasis added] of any species of vertebrate fish or wildlife which interbreeds when mature." NMFS has determined that, to qualify as a DPS, a Pacific salmon or O. mykiss population must be substantially reproductively isolated and represent an important component in the evolutionary legacy of the biological species. A population meeting these criteria is considered to be an "evolutionarily significant unit" (ESU) (56 FR 58612, November 20, 1991). In its listing determinations for Pacific salmonids under the ESA, NMFS has treated an ESU as constituting a DPS, and hence a "species," under the ESA.

Section 3 of the ESA defines an endangered species as "any species which is in danger of extinction throughout all or a significant portion of its range" and a threatened species as one "which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." The statute lists factors that may cause a species to be threatened or endangered (ESA section 4(a)(1)): (a) the present or threatened destruction, modification, or curtailment of its habitat or range; (b) overutilization for commercial, recreational, scientific, or educational purposes; (c) disease or predation; (d) the inadequacy of existing regulatory mechanisms; or (e) other natural or manmade factors affecting its continued existence.

Section 4(b)(1)(A) of the ESA requires NMFS to make listing determinations based solely on the best scientific and commercial data available after conducting a review of the status of the species and after taking into account efforts being made to protect the species (in this report the term "status" is used in the statutory context, referring to the ESA listing status of "threatened," "endangered," or listing not warranted). Accordingly, NMFS follows four steps in making its listing determinations for Pacific salmon and O. mykiss: (1) NMFS first determines whether a population or group of populations constitutes an ESU, or, in other words whether the populations should be considered a "species" within the meaning of the ESA; (2) NMFS then determines the viability of the ESU and the factors that have led to its decline; (3) NMFS assesses efforts being made to protect the ESU, determining if these efforts are adequate to mitigate threats to the species; and (4) based on the foregoing information and the statutory listing criteria, NMFS then proposes a listing determination of whether the species is threatened or endangered in a significant portion of its range.

### 1.2 Previous Federal ESA Actions Related to West Coast Salmonids

Pacific salmon and O. mykiss ESUs in California and the Pacific Northwest have suffered broad declines over the past hundred years. (In this document the scientific name "O. mykiss" refers to both anadromous steelhead and resident rainbow trout life-history forms). NMFS has conducted several ESA status reviews and status review updates for six biological species of Pacific salmon and O. mykiss in California, Oregon, Washington, and Idaho, identifying 51 ESUs and listing 26 of these ESUs as of today. Table 1 provides a summary of the previous NMFS scientific reviews of the viability of salmon and steelhead, as well as the ESA listing determinations for the 27 ESUs under review (inclusive of the 23 ESUs addressed in this report).

Table 1. Summary of previous ESA listing actions related to the 27 Evolutionarily Significant Units of West Coast salmon and Oncorhynchus mykiss under review

| Evolutionarily Significant Unit (ESU) | Current Endangered Species Act (ESA) Status | Year Listed | Previous ESA Listing Determinations – Federal Register Citations | Previous Scientific Viability Reviews and Updates |
|---|---|---|---|---|
| Snake River sockeye ESU………………………..……… | Endangered……… | 1991……… | 56 FR 58619; 11/20/1991 (Final rule)<br>56 FR 14055; 04/05/1991 (Proposed rule)……... | NMFS 1991a |
| Ozette Lake sockeye ESU…………………….….……… | Threatened………. | 1999……… | 64 FR 14528; 03/25/1999(Final rule)<br>63 FR 11750; 03/10/1998 (Proposed rule)……... | NMFS 1998d<br>NMFS 1997f |
| Sacramento River winter-run chinook ESU…………...…… | Endangered……… | 1994……… | 59 FR 440; 01/01/1994 (Final rule)<br>57 FR 27416; 06/19/1992 (Proposed rule)<br>55 FR 49623; 11/30/1990 (Final rule)<br>55 FR 12831, 04/06/1990 (Emergency rule)<br>55 FR 102260; 03/20/1990 (Proposed rule)<br>54 FR 10260; 08/04/1989 (Emergency rule)<br>52 FR 6041; 02/27/1987 (Final rule)…………… | |
| California Coastal chinook ESU…………………….......... | Threatened………. | 1999……… | 64 FR 50394; 09/16/1999 (Final rule)<br>63 FR 11482; 03/09/1998 (Proposed rule)……... | NMFS 1998b<br>NMFS 1999d |
| Upper Willamette River chinook ESU………………...…… | Threatened………. | 1999……… | 64 FR 14308; 03/24/99 (Final rule)<br>63 FR 11482; 03/09/1998 (Proposed rule)……... | NMFS 1998b<br>NMFS 1998e<br>NMFS 1999c |
| Lower Columbia River chinook ESU…………................... | Threatened………. | 1999……… | 64 FR 14308; 03/24/99 (Final rule)<br>63 FR 11482; 03/09/1998 (Proposed rule)……... | NMFS 1998b<br>NMFS 1998e<br>NMFS 1999c |
| Upper Columbia River spring-run chinook ESU…………... | Endangered........... | 1999……… | 64 FR 14308; 03/24/99 (Final rule)<br>63 FR 11482; 03/09/1998 (Proposed rule)……... | NMFS 1998b<br>NMFS 1998e<br>NMFS 1999c |
| Puget Sound chinook ESU…………………………..…... | Threatened……… | 1999……… | 64 FR 14308; 03/24/99 (Final rule) | NMFS 1998b |

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|---|---|---|---|---|
| | | | 63 FR 11482; 03/09/1998 (Proposed rule)…….. | NMFS 1998e<br>NMFS 1999c |
| Snake River fall-run chinook ESU……………………….... | Threatened………. | 1992……… | 63 FR 1807; 0/12/1998 (Proposal withdrawn)<br>59 FR 66784; 12/28/1994 (Proposed rule)<br>59 FR 42529; 08/18/1994 (Emergency rule)<br>57 FR 23458; 06/03/1992 (Correction)<br>57 FR 14653; 04/22/1992 (Final rule)<br>56 FR 29547; 06/27/1991 (Proposed rule)…….. | NMFS 1991c<br>NMFS 1999d |
| Snake River spring/summer-run chinook ESU…………..… | Threatened………. | 1992……… | 63 FR 1807; 0/12/1998 (Proposal withdrawn)<br>59 FR 66784; 12/28/1994 (Proposed rule)<br>59 FR 42529; 08/18/1994 (Emergency rule)<br>57 FR 23458; 06/03/1992 (Correction)<br>57 FR 34639; 04/22/92 (Final rule)<br>56 FR 29542; 06/27/1991 (Proposed rule)…….. | NMFS 1991b<br>NMFS 1998b |
| Central California Coast coho ESU…………………..……. | Threatened………. | 1996……… | 61 FR 56138;- 10/31/`996 (Final rule)<br>60 FR 38011; 07/25/1995 (Proposed rule)…….. | Bryant 1994<br>NMFS 1995a |
| Southern Oregon/Northern California Coast coho ESU…... | Threatened………. | 1997……… | 62 FR 24588; 05/06/1997 (Final rule)<br>60 FR 38011; 07/25/1995 (Proposed rule)…….. | NMFS 1997a<br>NMFS 1996c<br>NMFS 1996e<br>NMFS 1995a |
| Oregon Coast coho ESU…………………………..…….. | Threatened………. | 1998……… | 69 FR 19975; 04/15/2004 (Candidate list)<br>63 FR 42587; 08/10/1998 (Final rule)<br>62 FR 24588; 05/06/1997 (Proposal withdrawn)<br>61 FR 56138;10/31/1996 (6 mo. extension)<br>60 FR 38011; 07/25/1995 (Proposed rule)…….. | NMFS 1997a<br>NMFS 1996b<br>NMFS 1996d<br>NMFS 1995a |
| Lower Columbia River coho ESU……………………..…... | Candidate………... | 1995……… | 69 FR 19975; 04/15/2004 (Candidate list)<br>60 FR 38011; 07/25/1995 (Not warranted)……. | NMFS 1996e<br>NMFS 1995a<br>NMFS 1991a |
| Columbia River chum ESU……………………...………. | Threatened………. | 1999……… | 64 FR 14508; 03/25/1999 (Final rule) | NMFS 1997e<br>NMFS 1999b |

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|---|---|---|---|---|
| | | | 63 FR 11774; 03/10/1998 (Proposed rule)…….. | NMFS 1999c |
| Hood Canal summer-run chum ESU……………….....……... | Threatened………. | 1999……… | 64 FR 14508; 03/25/1999 (Final rule)<br>63 FR 11774; 03/10/1998 (Proposed rule)…….. | NMFS 1996d<br>NMFS 1997e<br>NMFS 1999b<br>NMFS 1999c |
| Central California Coast steelhead ESU……………….….….. | Threatened………. | 1997……… | 62 FR 43937; 08/18/1997 (Final rule)<br>61 FR 41541; 08/09/1996 (Proposed rule)…….. | NMFS 1996b<br>NMFS 1997b |
| California Central Valley steelhead ESU…………...……… | Threatened.……… | 1998……… | 63 FR 13347; 03/19/1998 (Final rule)<br>62 FR 43974; 08/18/1997 (6 mo. extension)<br>61 FR 41541; 08/09/1996 (Proposed rule)…….. | NMFS 1996b<br>NMFS 1997b<br>NMFS 1997c<br>NMFS 1997d<br>NMFS 1998a |
| Northern California steelhead ESU……..…….……………. | Threatened………. | 2000……… | 65 FR 36074; 06/07/2000 (Final rule)<br>65 FR 6960; 02/11/2000 (Proposed rule)<br>63 FR 13347; 03/19/1998 (Not Warranted)<br>62 FR 43974; 08/18/1997 (6 mo. extension)<br>61 FR 41541; 08/09/1996 (Proposed rule)…….. | NMFS 1996b<br>NMFS 1997c<br>NMFS 1998a<br>NMFS 2000 |
| Lower Columbia River steelhead ESU……….….…….…… | Threatened………. | 1998……… | 63 FR 13347; 03/19/1998 (Final rule)<br>62 FR 43974; 08/18/1997 (6 mo. extension)<br>61 FR 41541; 08/09/1996 (Proposed rule)…….. | NMFS 1996b<br>NMFS 1997c<br>NMFS 1997d<br>NMFS 1998a |
| Middle Columbia River steelhead ESU….….……………... | Threatened………. | 1999……… | 64 FR 14517; 03/25/1999 (Final rule)<br>63 FR 11798; 03/10/1998 (Proposed rule)<br>62 FR 43974; 08/18/1997 (6 mo. extension)<br>61 FR 41541; 08/09/1996 (Proposed rule)…….. | NMFS 1996b<br>NMFS 1997d<br>NMFS 1999a<br>NMFS 1999c |
| Upper Columbia River steelhead ESU…………...………… | Endangered...……. | 1997……… | 62 FR 43937; 08/18/1997 (Final rule)<br>61 FR 41541; 08/09/1996 (Proposed rule)…….. | NMFS 1996b<br>NMFS 1997b |
| Snake River Basin steelhead ESU……………..….………... | Threatened………. | 1997……… | 62 FR 43937; 08/18/1997 (Final rule)<br>61 FR 41541; 08/09/1996 (Proposed rule)…….. | NMFS 1996b<br>NMFS 1997b |

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|---|---|---|---|---|
| *ESUs lacking associated artificial propagation programs* | | | | |
| Central Valley spring-run chinook ESU……………..…….. | Threatened………. | 1999……… | 64 FR 50394; 09/16/1999 (Final rule)<br>63 FR 11482; 03/09/1998 (Proposed rule)……... | NMFS 1998b<br>NMFS 1999d |
| Southern California steelhead ESU……………...……...…. | Endangered……… | 1997……… | 67 FR 21568; 05/01/2002 (Redefinition of ESU)<br>62 FR 43937; 08/18/1997 (Final rule)<br>61 FR 41541; 08/09/1996 (Proposed rule)……... | NMFS 1996b<br>NMFS 1997b |
| South-Central California Coast steelhead ESU………..…... | Threatened………. | 1997……… | 62 FR 43937; 08/18/1997 (Final rule)<br>61 FR 41541; 08/09/1996 (Proposed rule)……... | NMFS 1996b<br>NMFS 1997b |
| Upper Willamette River steelhead ESU……………...…….. | Threatened………. | 1999……… | 64 FR 14517; 03/25/1999 (Final rule)<br>63 FR 11798; 03/10/1998 (Proposed rule)<br>62 FR 43974; 08/18/1997 (6 mo. extension)<br>61 FR 41541; 08/09/1996 (Proposed rule)……... | NMFS 1996b<br>NMFS 1997d<br>NMFS 1999a<br>NMFS 1999c |

### 1.3 Past Practice in Pacific Salmonid ESA Listing Determinations

In past ESA listing determinations, NMFS followed the four step approach described above. In determining the populations that comprise an ESU, NMFS focused its evaluations on naturally spawning populations and did not explicitly consider relationships with hatchery stocks (artificially propagated salmon and steelhead released into habitats within the historical geographic range of the ESU). Most of the listed ESUs have associated hatchery stocks, and in many cases the abundance of fish from hatcheries far exceeds that of "natural" fish (fish that were produced by naturally spawning in the natural environment, regardless of the origin of their parents). The manner in which the hatchery stocks associated with an ESU are considered in making a determination about whether the ESU should be listed can have a major effect on the outcome of that determination. In past evaluations of an ESU's viability and the factors that have led to its decline, NMFS determined that the best scientific indicator of an ESU's extinction risk is the viability of the naturally spawning populations in that ESU. Accordingly, NMFS focused its evaluations on whether the naturally spawned fish were, by themselves, viable in their natural ecosystem over the long term. In evaluating protective efforts, NMFS generally did not consider whether the existence of a hatchery stock or stocks might have potential for reducing the danger of extinction or the likelihood of endangerment for an ESU. NMFS generally considered artificial propagation as a factor for decline.

NMFS listed as "endangered" those ESUs whose naturally spawning populations were found to have a present high risk of extinction, and listed as "threatened" those ESUs likely to become endangered within the foreseeable future (that is, whose present risk of extinction was not high, but whose risk of extinction was likely to become high within a foreseeable period of time). If an ESU was determined to be in danger of extinction or likely to become so within the foreseeable future, NMFS then evaluated the associated hatchery stocks to determine how closely related they were to the naturally-spawning populations. This evaluation focused on the origin of the hatchery fish and their similarity to locally adapted natural fish. Factors included in this consideration were: genetic, life history, and habitat use characteristics; the degree to which the characteristics of the hatchery stock may have been altered over time; and other factors that would affect their biological usefulness for recovery.

Under NMFS' interim artificial propagation policy for Pacific salmonids (Interim Policy; 58 FR 17573, April 5, 1993), hatchery fish found to be part of the ESU were listed under the ESA only if they were considered essential for recovery (e.g., if it was determined that the hatchery stock contains a substantial portion of the genetic diversity remaining in the ESU). Under the Interim Policy, most hatchery stocks included in an ESU were not listed. In addition, resident O. mykiss populations (i.e. rainbow trout), included in steelhead ESUs were not listed when it was determined that the steelhead warranted listing, as the U.S. Fish and Wildlife Service (FWS) retains ESA jurisdiction over resident rainbow trout

### 1.4 Alsea Valley Alliance v. Evans

In September of 2001, the U.S. District Court in Eugene, Oregon, in Alsea Valley Alliance v. Evans (161 F. Supp. 2d 1154, D. Oreg. 2001; Alsea decision), set aside NMFS' 1998 ESA listing of Oregon Coast coho salmon (63 FR 42587; 08/10/1998). The Court ruled that the ESA does not allow NMFS to list a subset of an ESU, and that NMFS had improperly excluded stocks from the listing once it had decided that certain hatchery stocks were part of the ESU. Although the Court's ruling affected only one ESU, the interpretive issue raised by the ruling called into question nearly all of NMFS' Pacific salmonid listing determinations. The Court struck down the 1998 final rule listing Oregon coast coho as a threatened species, thus removing the ESU from the protections of the ESA. The Court remanded the case to NMFS for re-consideration consistent with the Alsea decision. NMFS did not contest the Court's ruling, and informed the Court it would comply. In November 2001 intervenors appealed the Court's ruling to the U.S. Ninth Circuit Court of Appeals. Pending resolution of the appeal, the Ninth Circuit stayed the District Court's remand order and invalidation of the 1998 listing. While the stay was in place, the Oregon Coast coho ESU was again afforded the protections of the ESA (Alsea Valley Alliance v. Evans, 9th Circuit appeal, No. 01-36071, December 14, 2001). On February 24, 2004, the Appeals Court dismissed the appeal, and dissolved its stay of the District Court's ruling in Alsea.

Following the District Court's ruling in the Alsea case, NMFS received several petitions addressing 17 listed salmonid ESUs, including five steelhead ESUs. These petitions cited the Alsea ruling and focused on NMFS' past practice of excluding certain within-ESU hatchery stocks from listing protection. Various litigants have also challenged the failure to list resident populations included in threatened and endangered steelhead ESUs. The anadromous form of O. mykiss (i.e., steelhead) is presently under NMFS' jurisdiction, while the resident freshwater forms, usually called "rainbow" or "redband" trout, are under FWS jurisdiction. In Environmental Defense Center et al. v. Evans et al. (EDC v. Evans, SACV-00-1212-AHS (EEA)), the plaintiffs argue that NMFS failed to include resident populations in the endangered listing of the Southern California steelhead ESU (62 FR 43937; 08/18/1997). In Modesto Irrigation District et al. v. Evans et al. (MID v. Evans, CIV-F-02-6553 OWW DLB (E.D.Cal)), the plaintiffs seek to invalidate NMFS' 1997 threatened listing of the Central Valley California steelhead ESU (63 FR 13347; 03/19/1998) for failing to list hatchery and resident populations identified as part of the ESU. This same factual situation is found in all listed steelhead ESUs; the listings do not include hatchery and/or resident populations considered to be part of the ESUs. To be consistent with the Court's ruling in the Alsea case, all populations or stocks (natural, hatchery, resident, etc.) included in an ESU must be listed if it is determined that the ESU is threatened or endangered under the ESA.

### 1.5 Initiation of Coast-wide ESA Status Reviews

As mentioned above, following the ruling in the Alsea case, NMFS received ten petitions seeking to delist, or to redefine and list, 17 ESUs of Pacific salmon and steelhead. NMFS determined that eight of these petitions presented substantial scientific and commercial information to suggest that the petitioned actions may be warranted for 16 ESUs.

The ESA requires that, as a consequence of accepting the above petitions, NMFS promptly commence a review of the species' status and make a finding within 12 months after receiving the petition, whether the petitioned action is warranted (ESA Section 4(b)(3)). There are 16 ESUs for which NMFS has statutory deadlines for the completion of ESA status reviews and listing determinations: seven chinook ESUs (the Upper Willamette River, Lower Columbia River, Upper Columbia River spring-run, Puget Sound, Snake River fall-run, and Snake River spring/summer-run chinook ESUs); three coho ESUs (the Central California Coast, Southern Oregon/Northern California Coast, and Oregon Coast coho ESUs); two chum ESUs (the Columbia River and Hood Canal summer-run chum salmon ESUs); and five steelhead ESUs (the Upper Willamette River, Lower Columbia River, Middle Columbia River, Upper Columbia River, and Snake River Basin steelhead ESUs).

The ESUs addressed in the current status review for West Coast salmon and steelhead ESUs include 26 previously listed ESUs, and one ESU designated as a candidate species (the Lower Columbia coho ESU). As part of its response to the ESA interpretive issues raised by the ruling in the Alsea case, NMFS elected to initiate status reviews for a total of 27 ESUs: 11 ESUs in addition to the 16 ESUs for which it had accepted delisting/listing petitions. As announced in a Federal Register notice published on February 11, 2002 (67 FR 6215), these 11 additional ESUs are: one sockeye ESU (the threatened Ozette Lake sockeye ESU); three chinook ESUs (the endangered Sacramento River winter-run chinook ESU, as well as the threatened Central Valley spring-run and California coastal chinook ESUs); three coho ESUs ( the threatened Central California Coast and Oregon Coast coho ESUs, as well as the candidate Lower Columbia River coho ESU); and four steelhead ESUs (the threatened South-Central California Coast, Central California Coast, California Central Valley, and Northern California steelhead ESUs) (as noted above, NMFS subsequently accepted petitions addressing the Central California and Oregon Coast coho ESUs). On December 31, 2002, NMFS announced that it would also elect to review the ESA listing status of Snake River sockeye and Southern California steelhead ESUs (67 FR 79898). NMFS has elected to conduct these additional status reviews to address any errors in the listing determinations brought to light by the Alsea decision, as well as to consider the most recent information available for these ESUs. At the time of the Alsea decision, NMFS was conducting a status review for the candidate Lower Columbia River coho ESU in response to a July 24, 2000, petition from Oregon Trout and co-petitioners (see 65 FR 66221, November 3, 2000). Accordingly, NMFS has elected to include the Lower Columbia River coho ESU in this status review effort for the other 26 ESUs. NMFS has not elected to conduct status reviews for any other candidate ESUs (e.g., the Puget Sound/Strait of Georgia coho, Central Valley fall and late-fall chinook, and Oregon Coast steelhead ESUs), or ESUs that NMFS has previously determined do not warrant ESA listing.

NMFS solicited information to ensure that the review of the ESA status for the 27 ESUs under review was based on the best available and most recent scientific and commercial data. Following an initial 60-day public comment period concerning 25 of the ESUs, which commenced on February 11, 2002 (67 FR 6215), NMFS re-opened the public comment period for an additional 30 days on June 13, 2002 (67 FR 40679). Information and comment was requested during an additional 60-day public comment period when NMFS announced that it would also be reviewing the status of the Snake

River sockeye and Southern California steelhead ESUs (67 FR 79898; December 31, 2002). In this latter public comment period NMFS specifically requested information concerning resident O. mykiss populations in the 10 steelhead ESUs under review (67 FR at 79900).

## 2. **Background**

### 2.1 Assessing Extinction Risk for Pacific Salmonids

#### 2.1.1 *Statutory Considerations*

Section 4(b) of the ESA requires the Secretary to make listing determinations after conducting a review of the status of the species, and after taking into account those efforts, if any, being made to protect the species. Such efforts being made to protect the species include "conservation" practices, defined by the ESA to include propagation and transplantation methods and procedures (Section 3(3)). The ESA requires that listing determinations be made solely on the basis of the best scientific and commercial data available to the Secretary. The ESA further requires that listing decisions must take into account all members of the defined species (Alsea Valley Alliance v. Evans, 161 F. Supp. 2d 1154, D. Oreg. 2001).

#### 2.1.2 *Viable Salmonid Populations*

In the case of Pacific salmonids, ESU-level extinction risk is evaluated at two levels: first, the viability at the simpler population level; and then, the collective viability at the ESU level. The viability of individual populations, or an ESU in-total, depends upon the abundance, productivity, spatial structure, and diversity of the individual populations comprising an ESU (McElhany et al. 2000, Ruckelshaus et al. 2002). The criteria for "Viable Salmonid Populations" (VSP; McElhany et al. 2000) are used to guide NMFS' risk assessments. The VSP criteria were developed to provide a consistent and logical reference for making viability determinations and are based upon a review and synthesis of the conservation biology and salmon literature. The four VSP criteria are universal indicators of species' viability, and individually and collectively function as reasonable predictors of extinction risk.

Factors considered in relating the population-level VSP criteria to ESU-level risk include: the total number of viable populations; the geographic distribution of these populations; the connectivity among populations; and the genetic, behavioral, and ecological diversity among populations. ESUs with fewer populations are more likely to become extinct due to catastrophic events, and have a lower likelihood that the necessary phenotypic and genotypic diversity will exist to maintain future viability. ESUs with limited geographic range are similarly at increased extinction risk due to catastrophic events. ESUs with populations that are geographically distant from each other, or are separated by severely degraded habitat, may lack the connectivity to function as metapopulations (i.e., a group of interconnected subpopulations) and are more likely to become extinct. ESUs with limited diversity are more likely to go extinct as the result of correlated environmental catastrophes or environmental change that occurs too rapidly for an evolutionary response. ESUs comprised of a small proportion of populations meeting or exceeding VSP criteria may lack the source populations to sustain the non-viable declining populations during environmental down-turns. ESUs consisting of a single population are especially vulnerable in this regard. These considerations are further detailed in McElhany et al. 2000 (and references therein). In short, a viable ESU has a negligible risk (over a time scale of 100 years) of going extinct as a result of normal environmental variation, genetic change, catastrophic events and human activity. Viable ESUs and populations have sufficient growth rates, possess variation in heritable traits, and are spatially distributed to survive environmental variation and natural and human induced catastrophes.

#### 2.1.3 *Consideration of Natural Populations in Assessing ESU Viability*

NMFS' Pacific Salmonid Biological Review Team (BRT) (an expert panel of scientists from several federal agencies including NMFS, FWS, and the U.S. Geological Survey) reviewed the viability and extinction risk of naturally spawning populations in the 27 ESUs that are the subject of current status review (NMFS 2003b). The BRT evaluated the risk of extinction based on the performance of the naturally spawning populations in each of the ESUs under the assumption that present conditions will continue into the future. The BRT did not explicitly consider current artificial propagation efforts in its evaluations. However, the benefits and risks associated with past artificial propagation efforts, as they are manifested in the present viability of natural populations in an ESU, were considered in the BRT's viability assessments.

The viability of the naturally spawned component of an ESU provides an important context for the consideration of artificial propagation in evaluating the extinction risk of an ESU in-total. ESUs that lack self-sustaining natural populations are not viable. Artificial propagation programs can, under the appropriate circumstances, benefit natural salmonid populations, however, natural populations sustained through artificial propagation by definition are not self sustaining. The VSP document (McElhany et al. 2000) notes that not all populations in an ESU need to meet the VSP guidelines for an ESU to be viable. A healthy salmonid metapopulation is expected to have some "source" populations exceeding VSP parameters, as well as some non-viable "sink" populations. The greater number of populations in an ESU that are meeting or exceeding VSP guidelines, the greater the certainty that the ESU in-total is viable and will remain so into the future. An ESU may be viable if it contains some "core" naturally spawned populations exceeding VSP, as well as some non-viable naturally spawned populations that are being sustained through artificial propagation. Uncertainty in assessing ESU-level viability increases with the proportion of ESU populations that are being supported by artificial propagation efforts. The presence of a large number of hatchery fish in an ESU is not sufficient to show that an ESU in-total is viable.

The BRT's assessment of ESU-level extinction risk uses categories that correspond to the definitions of endangered species and threatened species, respectively, in the ESA: in danger of extinction throughout all or a significant portion of its range, likely to become endangered within the foreseeable future throughout all or a significant portion of its range, or neither. As discussed above, these evaluations do not include consideration of hatchery stocks included in ESUs, and do not evaluate efforts being made to protect the species. Therefore, the BRT's findings, nor those of the Artificial Propagation Evaluation Workshop described in this report, are not to be considered recommendations regarding listing. The BRT's ESU-level extinction risk assessment reflects the BRT's professional scientific judgment, guided by the analysis of the VSP criteria, as well as by expectations of the likely interactions among the individual VSP criteria. For example, a single VSP criterion with a "High Risk" score might be sufficient to result in an overall extinction risk assessment of "in danger of extinction," but a combination of several VSP criteria with more moderate risk scores could also lead to the same assessment, or a finding that the ESU is "likely to become endangered."

#### 2.1.4 *Consideration of the Entire ESU in Assessing Viability*

As noted above, NMFS' previous policy for the consideration of artificial propagation in ESA listing determinations for Pacific salmonids (58 FR 17573, April 5, 1993) requires revision due to the District Court's ruling in the Alsea case. In its February 2002 response to the Alsea decision and various petitions (67 FR 6215; February 11, 2002), NMFS announced that it would revise this policy. The development of the revised policy has been delayed as NMFS resolved complex scientific and policy issues. However, a revised policy for the consideration of artificial propagation in ESA listing determinations (hereafter referred to as the proposed Hatchery Listing Policy) has been drafted and guided the consideration of artificial propagation for the Artificial Propagation Evaluation Workshop detailed in this report. The new Hatchery Listing Policy will be proposed in the issue of the Federal Register [INSERT FR CITATION FOR PROPOSED HATCHERY LISTING POLICY HERE] concurrent with the proposed listing determinations for the 27 ESUs under review.

The proposed Hatchery Listing Policy provides that status determinations for Pacific salmonid ESUs will be based on the likelihood of extinction of an entire ESU (including both hatchery and natural components). For those ESUs with associated hatchery programs, the BRT's findings represent a partial assessment of the ESU's extinction risk. To assess the viability of an entire ESU, NMFS also needs to assess the contributions of within-ESU hatchery programs to the viability of an ESU in-total.

NMFS' assessment of the effects of within-ESU hatchery programs on an ESU's viability and extinction risk is presented in the Salmonid Hatchery Inventory and Effects Evaluation Report (NMFS 2004b; hereafter referred to as the "SHIEER"). The SHIEER evaluates the effects of hatchery programs on the likelihood of extinction of an ESU on the basis of the four VSP criteria (i.e., abundance, productivity, spatial structure, and diversity) and how artificial propagation efforts within the ESU affect those criteria. In April 2004, NMFS convened an Artificial Propagation Evaluation Workshop of federal scientists and managers with expertise in salmonid artificial propagation. The Artificial Propagation Evaluation Workshop reviewed the BRT's findings (NMFS 2003a), evaluated the SHIEER (NMFS 2004b), and assessed the overall extinction risk of ESUs with associated hatchery stocks. This Artificial Propagation Evaluation Workshop Report presents the discussions and conclusions of the April 21-23, 2004 workshop.

### 2.2 Consideration of Artificial Propagation in ESU Viability Assessments

In assessing an ESU's viability, artificial propagation is first considered in determining what constitutes the ESU. Secondly, artificial propagation is considered when evaluating the extinction risk of the entire ESU. Below we overview how artificial propagation was evaluated in determining ESU membership and in assessing the viability of an entire ESU. For further discussion of artificial propagation in the context of ESA listing decisions, the reader is directed to the proposed Hatchery Listing Policy.

### 2.2.1 *Considering Artificial Propagation in Defining ESUs*

In the Alsea ruling the Court affirmed NMFS' interpretation of what constitutes a "distinct population segment" (i.e., the ESU Policy; 56 FR 58612; November 20, 1991), as a "permissible agency construction of the ESA" (Alsea Valley Alliance v. Evans, 1612 F. Supp. 2d 1154, 1161 (D. Oreg. 2001)). NMFS believes that the ESU policy provides appropriate guidance for the consideration of what populations (natural as well as hatchery or resident populations) constitute an ESU, and hence a "species" under the ESA. Under the ESU policy, a distinct population segment of a Pacific salmonid species is considered an ESU if it meets two criteria: (a) it must be substantially reproductively isolated from other conspecific population units; and (b) it must represent an important component in the evolutionary legacy of the species. A key feature of the ESU concept is the recognition of genetic resources that represent the ecological and genetic diversity of the species. These genetic resources can reside in a fish spawned in a hatchery (hatchery fish) as well as in a fish spawned in the wild (natural fish).

In delineating an ESU that is to be considered for listing, NMFS has identified all populations that are part of the ESU including populations of natural fish (natural populations), populations of hatchery fish (isolated hatchery stocks), and populations that include both natural fish and hatchery fish (integrated populations). Hatchery fish that are genetically no more than moderately divergent from a natural population in the ESU are considered part of the ESU, and were considered in determining whether an entire ESU should be listed under the ESA, and thus must be included in any listing of the ESU [INSERT FR CITATION FOR PROPOSED HATCHERY LISTING POLICY HERE].

To assist NMFS in determining the ESU membership of individual hatchery stocks, a Salmon and Steelhead Hatchery Assessment Group (SSHAG), composed of NMFS scientists from the Northwest and Southwest Fisheries Science Centers, evaluated the best available information describing the relationships between hatchery stocks and natural ESA-listed salmon and anadromous O. mykiss populations in the Pacific Northwest and California. The SSHAG produced a report, entitled "Hatchery Broodstock Summaries and Assessments for Chum, Coho, and Chinook Salmon and Steelhead Stocks within Evolutionarily Significant Units Listed under the Endangered Species Act" (NMFS 2003a), describing the relatedness of each hatchery stock on the basis of stock origin and the degree of known or inferred genetic divergence between the hatchery stock and the local natural population(s). NMFS utilized the information presented in the SSHAG Report to determine the ESU membership of those hatchery stocks determined to be within the historical geographic range of a given ESU. NMFS' assessment of individual hatchery stocks and its findings regarding their ESU membership are detailed in the SHIEER (NMFS 2004b). The hatchery stocks included in a given ESU are listed below in Table 2.

Table 2. List of artificial propagation programs included in Evolutionarily Significant Units (ESUs) of West Coast salmon and Oncorhynchus mykiss.

| Evolutionarily Significant Unit (ESU) | Artificial Propagation Program | Run | Location (State) |
|---|---|---|---|
| Snake River sockeye ESU……………...……..………… | Redfish Lake Captive Propagation Program………………………................... | n/a……… | Stanley Basin (Idaho) |
| Ozette Lake sockeye ESU…………………...…………….. | Umbrella Creek Hatchery – Makah Tribe…… | n/a……… | Ozette Lake (Washington) |
| | Big River Hatchery – Makah Tribe……..…… | n/a……… | Ozette Lake (Washington) |
| Sacramento River winter-run chinook ESU……………..... | Livingston Stone National Fish Hatchery (NFH) Conservation Program……...……….. | Winter…... | Sacramento River (California) |
| | Captive Broodstock Program.......................... | Winter…... | Livingston Stone NFH & Univ. of Calif. Bodega Marine Laboratory (California) |
| Central Valley spring-run chinook ESU………………..… | n/a | | |
| California Coastal chinook ESU……………..…………… | Freshwater Creek/Humboldt Fish Action Council…………………………………….. | Fall……… | Freshwater Creek, Humboldt Bay (California) |
| | Yager Creek Hatchery………………………. | Fall……… | Yager Creek, Van Duzen River (California) |
| | Redwood Creek Hatchery……………………. | Fall……… | Redwood Creek, South Fork Eel River (California) |
| | Hollow Tree Creek Hatchery……….……….. | Fall……… | Eel River (California) |
| | Mattole Salmon Group Hatchery…………….. | Fall……… | Squaw Creek, Mattole River (California) |
| | Van Arsdale Fish Station…………………….. | Fall……… | Eel River (California) |
| | Mad River Hatchery………………………….. | Fall………. | Mad River (California) |
| Upper Willamette River chinook ESU…………………...... | McKenzie River Hatchery (Oregon Department of Fish & Wildlife (ODFW) stock #24)……………………………………….. | Spring…... | McKenzie River (Oregon) |
| | Marion Forks Hatchery (ODFW stock #21)…. | Spring…... | North Fork Santiam River (Oregon) |
| | South Santiam Hatchery (ODFW stock #23)... | Spring…… | South Fork Santiam River (Oregon) |
| | ................................. | Spring…… | Calapooia River (Oregon) |

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| | ................................. | Spring…… | Mollala River (Oregon) |
| | Willamette Hatchery (ODFW stock #22)……. | Spring…… | Middle Fork Willamette River (Oregon) |
| | Clackamas Hatchery (ODFW stock # 19)…… | Spring…... | Clackamas River (Oregon) |
| Lower Columbia River chinook ESU…………………...… | Sea Resources Tule chinook Program ............ | Fall……… | Chinook River (Washington) |
| | Big Creek Tule chinook Program….......……. | Fall……… | Big Creek (Oregon) |
| | Astoria High School (STEP) Tule chinook Program………………….............................… | Fall...…… | Big Creek (Oregon) |
| | Warrenton High School (STEP) Tule chinook Program.......................……………………… | Fall……… | Big Creek (Oregon) |
| | Elochoman River Tule chinook Program......... | Fall...…… | Elochoman River (Washington) |
| | Cowlitz Tule chinook Program........................ | Fall……… | Lower Cowlitz River (Washington) |
| | North Fork Toutle Tule chinook Program…..... | Fall...…… | Cowlitz River (Washington) |
| | Kalama Tule chinook Program...…..………… | Fall……… | Kalama River (Washington) |
| | Washougal River Tule chinook Program...…... | Fall……… | Washougal River (Washington) |
| | Spring Creek NFH Tule Chinook Program...... | Fall........... | Upper Columbia River Gorge (Washington) |
| | Cowlitz spring chinook Program..................... | Spring…… | Upper Cowlitz River (Washington) |
| | ................................. | Spring…… | Cispus River (Washington) |
| | Friends of Cowlitz spring chinook Program..... | Spring…… | Upper Cowlitz River (Washington) |
| | Kalama River spring chinook Program............ | Spring....... | Kalama River (Washington) |
| | Lewis River spring chinook Program.............. | Spring....... | Lewis River (Washington) |
| | Fish First spring chinook Program.................. | Spring....... | Lewis River (Washington) |
| | Sandy River Hatchery (ODFW stock #11)...... | Spring....... | Sandy River (Oregon) |
| Upper Columbia River spring chinook ESU……………… | Twisp River………………………………….. | Spring…… | Methow River (Washington) |
| | Chewuch River............................................. | Spring…… | Methow River (Washington) |
| | Methow Composite…………………………... | Spring…… | Methow River (Washington) |
| | Winthrop NFH (Methow Composite stock)..... | Spring....... | Methow River (Washington) |
| | Chiwawa River………………………………. | Spring…… | Wenatchee River (Washington) |
| | White River…………………………………... | Spring…… | Wenatchee River (Washington) |
| Puget Sound chinook ESU……………………………..…. | Kendall Creek Hatchery……………………… | Spring…… | North Fork Nooksack River (Washington) |

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| | Marblemount Hatchery……………………… | Fall……… | Lower Skagit River (Washington) |
| | ……………………… | Spring (yearlings).. | Upper Skagit River (Washington) |
| | ……………………… | Spring (sub-yearlings)... | Upper Skagit River (Washington) |
| | ……………………… | Summer.… | Upper Skagit River (Washington) |
| | Harvey Creek Hatchery……………………… | Summer…. | North Fork Stillaguamish River (Washington) |
| | Whitehorse Springs Pond……………………. | Summer…. | North Fork Stillaguamish River (Washington) |
| | Wallace River Hatchery……………………… | Summer (yearlings)... | Skykomish River (Washington) |
| | ……………………… | Summer (sub-yearlings)... | Skykomish River (Washington) |
| | Tulalip Bay (Bernie Kai-Kai Gobin Hatchery/Tulalip Hatchery)………………….. | Summer..... | Skykomish River/Tulalip Bay (Washington) |
| | Soos Creek Hatchery………………………… | Fall……… | Green River (Washington) |
| | Icy Creek Hatchery………………………... | Fall……… | Green River (Washington) |
| | Keta Creek – Muckelshoot Tribe…………….. | Fall……… | Green River (Washington) |
| | White River Hatchery……………………... | Spring…… | White River (Washington) |
| | White Acclimation Pond…………...……….. | Spring…… | White River (Washington) |
| | Hupp Springs Hatchery…………..………... | Spring…… | White River (Washington) |
| | Voights Creek Hatchery……………………… | Fall……... | Puyallup River (Washington) |
| | Diru Creek…………………………………… | Fall……… | Puyallup River (Washington) |
| | Clear Creek…………..……………………. | Fall……… | Nisqually River (Washington) |
| | Kalama Creek………..……………………. | Fall……… | Nisqually River (Washington) |
| | Dungeness/Hurd Creek Hatchery..…………... | Spring…… | Dungeness River (Washington) |
| | Elwha Channel Hatchery…...……………….. | Fall……… | Elwha River (Washington) |
| Snake River fall-run chinook ESU………………………… | Lyons Ferry Hatchery……………………... | Fall……… | Snake River (Idaho) |
| | Fall Chinook Acclimation Ponds Program – Pittsburg, Captain John, and Big Canyon ponds………………………………………. | Fall………. | Snake River (Idaho) |

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| | Nez Perce Tribal Hatchery – including North Lapwai Valley, Lakes Gulch, and Cedar Flat Satellite facilities……….……………………. | Fall……… | Snake and Clearwater Rivers (Idaho) |
| | Oxbow Hatchery…………………………….. | Fall……… | Snake River (Oregon, Idaho) |
| Snake River spring/summer-run chinook ESU………….... | Tucannon River Hatchery (conventional)……. | Spring…… | Tucannon River (Idaho) |
| | Tucannon River Captive Broodstock Program. | Spring…… | Tucannon River (Idaho) |
| | Lostine River (captive/conventional)……….. | Summer…. | Grande Ronde (Oregon) |
| | Catherine Creek (captive/conventional)……... | Summer…. | Grande Ronde (Oregon) |
| | Lookingglass Hatchery (reintroduction)……... | Summer…. | Grande Ronde (Oregon) |
| | Upper Grande Ronde (captive/conventional)... | Summer…. | Grande Ronde (Oregon) |
| | Imnaha River………………………………. | Spring/ Summer…. | Imnaha River (Oregon) |
| | Big Sheep Creek…………………………….. | Spring/ Summer…. | Imnaha River (Oregon) |
| | McCall Hatchery…………………………….. | Spring…… | South Fork Salmon River (Idaho) |
| | Johnson Creek Artificial Propagation Enhancement.………………………………. | Spring…… | East Fork South Fork Salmon River (Idaho) |
| | Lemhi River Captive Rearing Experiment…... | Spring…… | Lemhi River (Idaho) |
| | Pahsimeroi Hatchery………………………. | Summer…. | Salmon River (Idaho) |
| | East Fork Captive Rearing Experiment……… | Spring…… | East Fork Salmon River (Idaho) |
| | West Fork Yankee Fork Captive Rearing Experiment………………………………... | Spring…… | Salmon River (Idaho) |
| | Sawtooth Hatchery…………………………. | Spring…... | Upper Mainstem Salmon River (Idaho) |
| Central California Coast coho ESU…………………...….. | Don Clausen Fish Hatchery Captive Broodstock Program....................................... | n/a……… | Dry Creek, Russian River (California) |
| | Scott Creek/Kingfisher Flat Hatchery Conservation Program (Monterey Bay Salmon and Trout Project)………………………….……. | n/a……… | Big Creek, Scott Creek (California) |
| | Scott Creek Captive Broodstock Program …... | n/a……… | NOAA Southwest Fisheries Science Center, Santa Cruz (California) |
| | Noyo River Fish Station egg-take program….. | n/a……… | Noyo River (California) |

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| Southern Oregon/Northern California Coast coho ESU….. | Cole Rivers Hatchery (ODFW stock #52)........ | n/a……… | Rogue River (Oregon) |
| | Trinity River Hatchery……………………….. | n/a……… | Trinity River (California) |
| | Iron Gate Hatchery…………………………… | n/a……… | Klamath River (California) |
| Oregon Coast coho ESU…………………...…………… | North Umpqua River (ODFW stock #55)…... | n/a……… | Umpqua River (Oregon) |
| | Cow Creek (ODFW stock #18)…....……….... | n/a……… | Umpqua River (Oregon) |
| | Coos Basin (ODFW stock #37)……..………. | n/a……… | Coos Basin (Oregon) |
| | Coquille River/Bandon Hatchery (ODFW 44)…………………………………………… | n/a……… | Coquille River (Oregon) |
| | North Fork Nehalem River (ODFW stock #32)................................................................ | n/a……… | Nehalem River (Oregon) |
| Lower Columbia River coho ESU…………...……………. | Grays River………………………………... | Type-S…... | Grays River (Washington) |
| | Sea Resources Hatchery……………………… | Type-S…... | Grays River (Washington) |
| | Peterson Coho Project…..…………………… | Type-S…... | Grays River (Washington) |
| | Big Creek Hatchery (ODFW stock # 13)…….. | n/a……… | Big Creek (Oregon) |
| | Astoria High School (STEP) Coho Program… | n/a……… | Youngs Bay (Oregon) |
| | Warrenton High School (STEP) Coho Program……………………………………… | n/a……… | Youngs Bay (Oregon) |
| | Elochoman Type-S Coho Program…………... | Type-S…... | Elochoman River (Washington) |
| | Elochoman Type-N Coho Program………….. | Type-N….. | Elochoman River (Washington) |
| | Cathlamet High School FFA Type-N Coho Program……………………………………… | Type-N….. | Elochoman River (Washington) |
| | Cowlitz Type-N Coho Program……………… | Type-N….. | Upper Cowlitz River (Washington) |
| | Cowlitz Type-N Coho Program……………… | Type-N….. | Lower Cowlitz River (Washington) |
| | Cowlitz Game and Anglers Coho Program….. | n/a……… | Lower Cowlitz River (Washington) |
| | Friends of the Cowlitz Coho Program……….. | n/a……… | Lower Cowlitz River (Washington) |
| | North Fork Toutle River Hatchery………….... | Type-S…... | Cowlitz River (Washington) |
| | Lewis River Type-N Coho Program………… | Type-N….. | North Fork Lewis River (Washington) |
| | Lewis River Type-S Coho Program………… | Type-S…... | North Fork Lewis River (Washington) |
| | Fish First Wild Coho Program……………… | n/a……… | North Fork Lewis River (Washington) |
| | Fish First Type-N Coho Program…………… | Type-N….. | North Fork Lewis River (Washington) |

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| | Syverson Project Type-N Coho Program……. | Type-N….. | Salmon River (Washington) |
| | Sandy Hatchery (ODFW stock # 11)………… | Late…….. | Sandy River (Oregon) |
| | Bonneville/Cascade/Oxbow Complex (ODFW stock # 14)…………………………………… | n/a……… | Lower Columbia River Gorge (Oregon) |
| Columbia River chum ESU……………………………….. | Chinook River/Sea Resources Hatchery…….. | Fall…….... | Chinook River (Washington) |
| | Grays River..................... …………………… | Fall…….... | Grays River (Washington) |
| | Washougal Hatchery/Duncan Creek………… | Fall…….... | Washougal River (Washington) |
| Hood Canal summer-run chum ESU………………………. | Quilcene/ Quilcene NFH……………...…….. | Summer…. | Big Quilcene River (Washington) |
| | Hamma Hamma Fish Hatchery……………… | Summer…. | Western Hood Canal (Washington) |
| | Lilliwaup Creek Fish Hatchery………..……… | Summer…. | Southwestern Hood Canal (Washington) |
| | Union River/Tahuya……..................………... | Summer…. | Union River (Washington) |
| | Big Beef Creek Fish Hatchery……………….. | Summer…. | North Hood Canal (Washington) |
| | Salmon Creek Fish Hatchery..........………… | Summer…. | Discovery Bay (Washington) |
| | Chimacum Creek Fish Hatchery..........……… | Summer…. | Port Townsend Bay (Washington) |
| | Jimmycomelately Creek Fish Hatchery……... | Summer…. | Sequim Bay (Washington) |
| Southern California O. mykiss ESU…………………..... | n/a | | |
| South-Central California Coast O. mykiss ESU……..…..... | n/a | | |
| Central California Coast O. mykiss ESU………………...…. | Scott Creek/Monterey Bay Salmon and Trout Project, Kingfisher Flat Hatchery…………… | Winter…... | Big Creek, Scott Creek (California) |
| | Don Clausen Fish Hatchery………………….. | Winter…... | Russian River (California) |
| California Central Valley O. mykiss ESU………......…….. | Coleman NFH……………………………….. | Winter…... | Battle Creek, Sacramento River (California) |
| | Feather River Hatchery……………………… | Winter…... | Feather River (California) |
| Northern California O. mykiss ESU……...…...………….. | Yager Creek Hatchery…………………..….. | Winter…... | Yager Creek, Van Duzen River (California) |
| | North Fork Gualala River Hatchery/Gualala River Steelhead Project……………………… | Winter…... | North Fork Gualala River (California) |
| Upper Willamette River O. mykiss ESU……...………...… | n/a | | |

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| Lower Columbia River O. mykiss ESU……………..…….. | Cowlitz Trout Hatchery………………..…….. | Late Winter…... | Cispus River (Washington) |
| | Cowlitz Trout Hatchery………………..…….. | Late Winter…... | Upper Cowlitz River (Washington) |
| | Cowlitz Trout Hatchery………………..…….. | Late Winter…... | Tilton River (Washington) |
| | Cowlitz Trout Hatchery………………..…….. | Late Winter…... | Lower Cowlitz River (Washington) |
| | Kalama River Wild……..…………………… | Winter…... | Kalama River (Washington) |
| | ………………………………... | Summer…. | Kalama River (Washington) |
| | Clackamas Hatchery (ODFW stock # 122)….. | Late Winter…... | Clackamas River (Oregon) |
| | Sandy Hatchery (ODFS stock # 11)………… | Late Winter…... | Sandy River (Oregon) |
| | Hood River (ODFW stock # 50)……………... | Winter…... | Hood River (Oregon) |
| | ……………... | Summer…. | Hood River (Oregon) |
| Middle Columbia River O. mykiss ESU…..………………. | Touchet River Endemic...............…………… | Summer…. | Touchet River (Washington) |
| | Yakima River Kelt Reconditioning Program… | Summer…. | Satus Creek (Washington) |
| | ……………... | Summer…. | Toppenish Creek (Washington) |
| | ……………... | Summer…. | Naches River (Washington) |
| | ……………... | Summer…. | Upper Yakima River (Washington) |
| | Umatilla River (ODFW stock # 91)………….. | Summer…. | Umatilla River (Oregon) |
| | Deschutes River (ODFW stock # 66)………... | Summer…. | Deschutes River (Oregon) |
| Upper Columbia River O. mykiss ESU……..……..…….. | Wenatchee River Steelhead...………………... | Summer…. | Wenatchee River (Washington) |
| | Wells Hatchery Steelhead……………………. | Summer…. | Methow River (Washington) |
| | ……………... | Summer…. | Okanogan River (Washington) |
| | Winthrop NFH Steelhead (Wells Steelhead).... | Summer…. | Methow River (Washington) |
| | Omak Creek Steelhead……………………….. | Summer…. | Okanogan River (Washington) |
| | Ringold Hatchery (Wells Steelhead)……..….. | Summer…. | Middle Columbia River (Washington) |
| Snake River Basin O. mykiss ESU………………...…...…. | Tucannon River……………………………… | Summer…. | Tucannon River (Washington) |

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| | Dworshak NFH……………………………… | Summer…. | South Fork Clearwater River (Idaho) |
| | Lolo Creek…………………………………… | Summer…. | Salmon River (Idaho) |
| | North Fork Clearwater………………………. | Summer…. | North Fork Clearwater River (Idaho) |
| | East Fork Salmon River……………………… | Summer…. | East Fork Salmon River (Idaho) |
| | Little Sheep Creek/Imnaha River Hatchery (ODFW stock # 29)………………………….. | Summer…. | Imnaha River (Oregon) |

### 2.4.2 *Weighing the Benefits and Risks of Artificial Propagation*

Hatcheries have been used for more than 100 years in attempts to increase salmon production and to mitigate the effects of human activities on salmon. For many years, people did not recognize the potential for hatchery fish to adversely affect wild fish and did not believe that there was any limit to the capacity of marine and freshwater habitats to provide the necessary resources for salmon growth and survival (NRC 1998). Not until the late 1930s was the life cycle of salmon, and their ability to return to their natal streams to spawn, accepted as a mechanism for development and maintenance of a metapopulation structure comprising many populations adapted to local environmental conditions (Lichatowich 1999). Without this knowledge, hatchery managers freely engaged in the interbasin (even interstate) transfer of eggs and fish with the goal of maximizing hatchery production, while the concomitant adverse effects of those transfers on wild population diversity, integrity, and productivity went unnoticed. Even in the face of this knowledge, these practices continued, well into the 20th century.

Today, hundreds of hatcheries continue to produce Pacific salmon and steelhead to meet treaty and trust obligations to Indian tribes, to provide for commercial and sport fisheries, and to mitigate for the impacts of development projects such as dams for hydropower, irrigation, and flood control. They remain an important, and in many cases required, part of salmon management strategies in the west. Most of the salmon and O. mykiss ESUs under review have associated hatchery programs that release artificially propagated salmon and steelhead into habitats within the historic geographic range of the ESU.

Depending upon management practices and the extent to which local natural fish are used for broodstock, hatchery programs may be relatively isolated from, or integrated with, local natural populations. Although each hatchery program is unique, hatcheries generally have either or both of two basic goals: (1) to produce fish for harvest (including mitigation for lost production due to habitat loss or degradation); and (2) to help recover or conserve natural populations. Hatchery programs aimed at conserving or recovering wild populations intentionally integrate wild populations and hatchery stocks: naturally spawned fish are incorporated each year into the hatchery broodstock in varying proportions, and the returning adult hatchery fish are intentionally allowed to spawn and reproduce in the natural environment. These programs aimed at conserving natural populations take efforts to maintain natural genetic diversity and behaviors in the hatchery stocks. The two goals of harvest augmentation and conservation are not necessarily mutually exclusive, and there are many programs that strive to conserve natural populations while producing excess fish for harvest.

Numerous high-profile scientific panels have concluded that artificial propagation can potentially benefit or decrease the viability of salmonid populations (e.g., ISAB 2003, IMST 2001, ISAB 2001, HSRG 2000). Past hatchery strategies and practices have posed threats to natural populations. However, a reformed hatchery system could potentially play an important role in salmon recovery, by helping to avoid the extinction of endangered populations and to increase the abundance of populations that have been severely impacted by habitat degradation or overexploitation. Hatcheries may potentially play an important role in helping to recover salmon populations by rebuilding abundance and attempting to maintain an ESU's spatial structure and genetic diversity. There remains considerable uncertainty, however, regarding the relative likelihood and magnitude of risks and benefits from hatcheries. Nonetheless, the clear and unavoidable conclusion from the various scientific panels is that in order to assure the long-term persistence of salmon, it will be necessary to institute habitat, hydrosystem management, and harvest reforms to create or conserve ecosystem conditions that allow for viable naturally spawning salmonid populations.

Specific considerations of artificial propagation in evaluating an ESU's abundance, productivity, spatial structure, and diversity are described below:

Abundance – Segregated hatchery programs (programs that do not regularly incorporate natural fish for broodstock, or that are otherwise not intended to be integrated with local natural populations) have demonstrated the potential to artificially produce large numbers of fish. However, they are not designed for, and do not generally succeed at, increasing the abundance of natural-origin spawners. Ecological and genetic interactions between segregated hatchery programs and local natural populations cannot always be effectively controlled. In general, segregated hatchery programs may have a deleterious effect on an ESU's abundance.

Modern "integrated" hatchery programs (programs using local, natural-origin broodstock and other "best management practices") are designed around the needs of natural populations, and have the potential to help increase both the total (hatchery and natural abundance) and natural-origin abundance. Such potential benefits can provide benefits to an ESU's abundance in the short term, however the contribution over the long term is uncertain. Long-term reliance on these programs, without addressing the habitat or other factors limiting the natural populations, is of limited value.

Productivity – There is no evidence that the straying of fish from a segregated hatchery program into a naturally spawning population can improve a population's natural rate of growth, and there is some evidence that these fish can reduce fitness of natural populations. Reducing or reforming segregated hatchery production may lead to improvements in the growth rates of affected natural populations, and thereby an ESU's productivity in-total.

Integrated hatchery programs often have higher per capita population growth rates than natural populations. In part due to their short track record, there is little direct information available regarding the effects of integrated hatcheries on natural population growth rates, or an ESU's overall productivity. Conceptually, integrated hatchery programs are unlikely to improve natural population growth rates except in cases where the natural population's small size is, in itself, a predominant factor limiting population growth. There is little information available to predict the contribution of artificial propagation to the productivity of an ESU in-total.

Spatial Structure – Segregated hatchery programs probably do little to benefit an ESU's spatial structure, except perhaps to maintain the presence of salmon in streams that are too degraded to support natural production.

Integrated hatchery programs that adhere to best management practices and reintroduce fish into streams and watersheds in which natural populations have been extirpated, may improve an ESU's spatial structure. When populations are depressed, the remaining individuals occupy the most desirable habitats, resulting in a reduced spatial distribution. Conceptually, an increase in abundance due to hatchery supplementation could result in the expansion of natural populations back into the less populated habitats, producing a beneficial increase in an ESU's spatial structure and population connectivity. Integrated hatchery programs following best management practices also have the potential to improve spatial structure by maintaining populations in streams while conservation efforts restore essential habitats. All hatcheries have the potential to disrupt an ESU's spatial structure, by, for example, using weirs that impede access to habitat.

Diversity – Segregated hatchery programs, through the use of poor broodstock practices, may reduce an ESU's genetic, ecological and behavioral diversity. However, many integrated hatcheries have the potential to help preserve an ESU's diversity in the short term by acting as a "genetic reserve" or "safety net.". For example, hatcheries could temporarily support natural populations that might otherwise be extirpated or suffer severe bottlenecks. Hatchery programs also have the potential to increase the genetically effective size of small natural populations, although this must done with care to avoid adverse genetic effects. Well designed and implemented integrated hatchery programs have the potential to help preserve an ESU's diversity over the short term. h

Evaluating Inherent Uncertainties – Artificial propagation efforts represent a level of human intervention with a unique suite of benefits, risks, and uncertainties. Whether artificial propagation affects an ESU's risk of extinction depends upon the ability of the hatchery program(s) to effectively contribute to the collective viability of populations within the ESU, and also depends upon whether the hatchery program(s) are likely to continue operations sufficiently into the future such that potential benefits may be realized. Factors considered in evaluating the potential effectiveness of artificial propagation programs include but are not limited to: 1) the primary objective of the program (e.g., conservation of genetic resources, reintroduction, supplementation, providing harvest opportunities); 2) the size or scale of the program relative to the carrying capacity of the ecosystem; 3) the source and proportion of natural-origin fish used for broodstock; 4) the number of natural-origin fish collected for broodstock relative to the number allowed to spawn naturally; 5) the extent to which the fish collected for broodstock are representative of the traits of local natural-origin fish (e.g., run timing, size at maturity, habitat use); 6) the program's mating protocols and genetic management plan; 7) the rearing conditions relative to the natural environment; 8) the proportion of hatchery fish that are released marked; 9) the rearing and release strategies relative to the natural life history; 10) the proportion of hatchery-origin fish on spawning ground s; 11) the program's disease and handling protocols; 12) the monitoring, evaluation, and adjustment procedures of the program; and 13) safeguards against facility malfunctions and operator errors. Factors considered in evaluating the prospects of artificial propagation programs continuing operations into the future include but are not limited to: 1) the availability of funding and staff resources; 2) program authorization (e.g., approval of hatchery genetic management plans under limit 5 of the ESA 4(d) rule for threatened ESUs, a current section 10(a)(1)(A) enhancement permit); and (3) if a program is part of a larger conservation plan, the level of participation and coordination in, and the timetable for, the plan.

Summary – Well designed and implemented hatchery programs have the potential to help improve an ESU's viability. The best-documented examples of benefits are in abundance, but potential benefits to spatial structure and diversity may also be possible. Except in rare circumstances, hatchery programs cannot be expected to improve an ESU's productivity. Any hatchery program, no matter how well designed, poses some risk to the natural population(s) it may be trying to conserve. Recent attention has been given to developing and testing new hatchery management protocols. In evaluating the net effects of programs, it is therefore necessary to understand the status of the target population(s) and evaluate the collective benefits and risks of the artificial propagation program(s) included in an ESU on a case-by-case basis.

## 3. Discussion and Clarification of Issues

### 3.1 Clarification of Roles for Workshop Participants and Observers

The Artificial Propagation Evaluation Workshop was attended by 46 federal fisheries scientists and managers (see Appendix 2 for a roster of attendees). The specific tasks of the workshop for each ESU under review with associated artificial propagation programs was to: (1) review the BRT's findings on the viability and extinction risk for the ESU (NMFS 2003b); (2) evaluate the findings of the SHIEER (NMFS 2004b) describing the ESU membership of hatchery programs, and assessing the contribution of these programs the viability of individual populations and the ESU in-total; and (3) assess the overall extinction risk of the ESU, considering both natural and hatchery produced ESU components. The attendees consisted of approximately 15 workshop "Participants", and 31 workshop "Observers." All workshop attendees (i.e., Participants and Observers) were involved in the review and discussion of the BRT's findings, and the evaluation of the Salmonid Hatchery Inventory and Effect Evaluation Report (tasks (1) and (2) above). The workshop Participants included federal scientists with technical expertise in salmonid artificial propagation from NMFS' Northwest Region Salmon Recovery Division, NMFS' Southwest Region Protected Resources Division, and the FWS. Workshop Participants engaged in the assessments of overall viability for the ESUs under review, and contributed to the workshop's findings regarding the extinction risk of entire ESUs (i.e., task (3) above). Workshop Observers (including policy staff, staff supervisors, NMFS administrators, NOAA general counsel, BRT members, and scientists from NMFS' Northwest and Southwest Fisheries Science Centers) did not participate in these ESU-level viability evaluations, or in the assessments of extinction risk for ESUs in-total. Representatives of the BRT and NMFS' Northwest and Southwest Fisheries Science Centers attended the workshop as Observers in an advisory capacity, to ensure that the BRT's findings were appropriately and accurately considered, as well as to help ensure that the workshop Participants were aware of the best available scientific information. The information considered by the workshop Participants in assessing the extinction risk of ESUs included the critique, discussion, and breadth of opinion offered by all workshop attendees in steps (1) and (2) above. The workshop Participants:

considered the information presented and discussed regarding the net contribution of within-ESU hatchery programs to the abundance, productivity, spatial structure, and diversity of the ESU in-total; and evaluated whether the inclusion of artificially propagated fish increased, reduced, or had no effect on the extinction risk of the ESU in-total, relative to the BRT's extinction risk assessments for the natural populations in an ESU. The workshop's findings of extinction risk for the ESUs described in this report represent the "weight of opinion" of the workshop Participants. Any opinion(s) dissenting from the "weight of opinion" are also described in the ESU-specific summaries provided in the following section (Section 4, "Overview of Workshop Discussion and Findings for Twenty-Three ESUs").

### 3.2 Clarification of Proposed Hatchery Listing Policy

A one-page summary of the proposed Hatchery Listing Policy was provided at the workshop (Appendix 3). There was considerable discussion among the workshop attendees regarding the interpretation, application, and implications of the proposed Hatchery Listing Policy.

The Hatchery Listing Policy is intended to apply equally to ESUs at all levels of extinction risk. Specifically, the consideration of artificial propagation may influence evaluations of the immediacy of extinction risk in the short term(i.e., whether an ESU is "endangered" or "threatened), as well as evaluations of extinction risk in the foreseeable future (i.e., whether an ESU "threatened" or listing is not warranted).

A concern was raised by several workshop participants and observers that the proposed Hatchery Listing Policy could be interpreted to mean that an ESU could be determined to be viable (and thus not warrant listing) if it lacked extant natural populations. The VSP concept recognizes that not all populations in an ESU need to be naturally self-sustaining for the ESU to be viable. However, an important component of the ESU concept is that the ESU is subject to natural biological processes, including the dynamics of natural selection that define the ESU's evolutionary legacy and trajectory. The importance of an ESU's evolutionary legacy forged by natural selective processes is captured by the diversity VSP criterion. An ESU that resides completely, or largely, in artificial hatchery environments would face extreme risks to its diversity, providing a strong indication of extinction risk. The longer an ESU resides in hatcheries, the more it will genetically adapt to these artificial environments, selecting for traits that are beneficial to survival in the hatchery. It is reasonable to infer that as an ESU adapts to the hatchery environment, it will lose fitness in the wild. This inference is consistent with observations that hatchery fish in the wild often reproduce and survive at lower rates than wild fish do, and that these differences are often genetically based. At some point, an ESU dependent upon artificial propagation becomes so different from its locally adapted evolutionary legacy that it is likely to go extinct. Additionally, ESUs dependent upon the indefinite operation of hatcheries are subject to significant risks and uncertainties that natural populations do not face (e.g., funding cuts, changing societal priorities, etc.). Artificial propagation is inherently unstable, requiring continual and active input that if relaxed results in the extirpation of the propagated stock(s). This situation is intrinsically of higher risk than a situation where there are healthy natural populations, in productive habitat, independent of continued human intervention. There was agreement among workshop participants that hatchery programs can play an important role in the recovery and conservation of salmonid ESUs, but that there is great risk if an entire ESU consists of only hatchery-produced fish.

An alternative view posed by drafters of the proposed Hatchery Listing Policy (attending the workshop as Observers) was that the presence of natural populations is not required for an ESU to be viable. The Hatchery Listing Policy, consistent with the ESA, seeks to avoid the situation where there are no viable natural populations. However, such a situation does not necessarily dictate that the entire ESU is not viable, and thereby warrants listing. The Hatchery Listing Policy says that it is important to conserve natural populations, but it does not require that natural populations must be recovered or conserved in all circumstances. The proposed Hatchery Listing Policy provides that an ESU may be viable if the ESU in-total is sustainable, including the collective contributions of within-ESU hatchery programs and any extant natural populations. However, the Hatchery Listing Policy cautions that the presence of a large population of hatchery fish will not, by itself, be sufficient to demonstrate that an ESU is viable.

### 3.3 Clarification of Viable Salmonid Populations

The VSP criteria were developed under the presumption that for a population or ESU to be viable, it had to be naturally self-sustaining in its natural ecosystem. The workshop's consideration of the potential contributions of artificial propagation programs to the collective viability of salmonid populations and ESUs represents an extrapolation of the original VSP concept. That said, the VSP criteria do not preclude the inclusion of hatcheries in viable populations and ESUs.

Although the proposed Hatchery Listing Policy provides that extinction risk assessments will be based upon the viability of an entire ESU (including both its hatchery and naturally produced components), the policy does recognize the necessity of conserving natural populations within the ESU, in line with the ESA's stated purpose to conserve "the ecosystems upon which endangered and threatened species depend" (ESA section 2(b)). Natural populations that are stable or increasing, are spawning in the wild, and have adequate spawning and rearing habitat reduce the risk of extinction of the ESU. Hatchery programs employing best management practices can reduce the likelihood of extinction of an ESU by increasing the ESU's abundance and productivity, by improving spatial distribution, and by serving as a source population for repopulating unoccupied habitat. Conversely, a hatchery program managed without adequate consideration of conservation effects can reduce an ESU's productivity and diversity, and increase the likelihood of extinction.

### 3.4 Clarification of the Point of Reference for the Workshop's Evaluations

The point of reference for evaluating the positive and negative effects of hatchery programs on an ESU's viability is the current condition of the natural populations. The SHIEER's and the workshop's evaluations were not made relative to pristine or historical conditions in the absence of artificial propagation. The net effects of artificial propagation programs on the abundance, productivity, spatial structure, and diversity of an ESU were assessed relative to the risks identified for these criteria by the BRT. Although the BRT focused its analyses on the naturally spawned populations in an ESU, its assessments did consider the past impacts of artificial propagation as reflected in the current viability of natural populations. The BRT's risk assessments focused on whether an ESU was naturally self sustaining, questioning whether the ESU would persist in the absence of continued artificial propagation. The evaluations of the SHIEER and the workshop differed from those of the BRT by including an evaluation of the prospects for the continued beneficial operation of within-ESU hatchery programs, and assessing whether an ESU in-total would be viable into the future. The SHIEER and the workshop explicitly considered: the abundance of hatchery-origin fish in evaluating risks to an ESU's abundance; the concrete-to-concrete replacement rates of hatchery programs in evaluating an ESU's productivity; the distribution of hatchery-origin fish, reintroductions, and range expansions back into extirpated habitats in evaluating risk to an ESU's spatial structure; and the genetic and life-history similarities between natural-origin and hatchery-origin fish in evaluating risks to an ESU's diversity.

### 3.5 Discussion of the Potential Contributions of Hatchery Programs to ESU Viability Criteria

There was general agreement among workshop attendees that artificial propagation programs can increase the total abundance of fish in an ESU in the short term, and under some circumstances increase the total numbers of fish spawning naturally in the wild. It is worth noting that increasing abundance reduces an ESU's extinction risk particularly when populations are at very low (depensatory) abundance levels. One cannot assume that further increases in abundance will result in additional reductions in extinction risk. Artificial supplementation of abundance to levels exceeding what the natural environment can support can result in increased competition for resources, reduced reproductive success, and an increased risk of extinction. There is considerable uncertainty regarding the ability of artificial propagation to sustain increases in an ESU's abundance over the long-term. There are some examples of hatchery programs successfully producing fish over several decades (e.g., the Big Creek coho hatchery program in operation since 1938, the Kalama River fall-run chinook program operating since 1898, and the Kendall Creek spring-run and fall-run chinook hatchery programs operating since 1899). Judging the performance of these hatchery programs is confounded by the inability to distinguish between hatchery and natural-origin returns (distinguishing between natural and hatchery production is a very recent development, and it is still not feasible for many integrated populations). In the past, these long-lived hatchery programs were not isolated and likely incorporated an unknown proportion of natural fish with each generation. Accordingly, it is difficult to evaluate the sustainability of isolated hatchery production over the long term. Although there are examples of hatchery programs that have persisted for relatively long periods of time, there are many examples of hatchery programs that have been initiated and failed, or are currently failing, for a variety of reasons. The mixed track record of artificial propagation over the long-term confers considerable uncertainty in attributing long-term benefits of hatchery programs to an ESU's total abundance. Operational threats to hatchery programs (e.g., facility malfunctions, disease, environmental catastrophic events, domestication and artificial selection, and loss of fitness and diversity) further contribute to the uncertainty of the potential long-term benefits of artificial propagation to an ESU's abundance.

It is unlikely that artificial propagation can provide a net benefit to an ESU's productivity. A "productive" hatchery program provides a survival benefit to the fish it produces by circumventing life-history stages that otherwise would experience high levels of mortality in the natural environment. In this sense, on might view hatcheries as greatly increasing an ESU's productivity. However, a hatchery program that is sustaining itself operates, at best, at capacity with a replacement rate of one. The strong weight of opinion of the workshop attendees was that productivity should be viewed as the collective contribution of natural-origin and hatchery-origin spawners to productivity in the natural environment. If hatchery fish exhibit equal reproductive fitness to natural fish, hatchery supplementation would not result in an increase in per capita growth rates (i.e., productivity). Rather, the survival advantage provided in the hatchery may result in an augmented abundance of ocean recruits, and potentially increase the total abundance fish spawning naturally. Accordingly, the ability of hatchery programs to produce fish is not reflected in benefits to productivity, but rather in the augmented abundance of total recruits and natural spawners. A prerequisite for a hatchery program to contribute to an ESU's abundance, and thereby not represent a drain on the local natural population(s) and the ESU in-total, is that it has a concrete-to-concrete productivity above replacement. The productivity index of an ESU in-total that provides a meaningful index of an ESU's extinction risk is the productivity of naturally spawning fish (including both natural and hatchery origin fish) in the natural environment.

The workshop attendees discussed whether the presence of a hatchery program in the same watershed as a natural population confers a benefit to an ESU's spatial structure by providing a "safety net" against the extirpation of the natural population due to catastrophic events. One opinion was that hatchery programs situated in the same watershed as natural populations do not increase spatial distribution of populations in an ESU, nor do they benefit the connectivity among populations. The "safety net" provided by these programs from the catastrophic loss of natural populations is better articulated in the context of a "genetic reserve", or as a benefit to an ESU's diversity. The principal potential benefit of artificial propagation to an ESU's spatial structure is i when hatchery fish are being re-introduced into extirpated habitat(s).

An alternative opinion was that artificial propagation programs can be viewed as a "refuge population" or an "artificial habitat patch" designed to buffer a local naturally spawning population against catastrophic events. Although a hatchery can also be prone to such catastrophic events, the same catastrophic event may not impact the natural and refuge populations equally or at the same time. In this sense, artificial propagation programs can spread the risk of spatially correlated environmental catastrophes. Workshop attendees cautioned, however, that despite this potential risk reduction in spatial structure, an emphasis must be placed on the need for maintaining production in the natural environment (Waples 1991a, 1991b; Hard *et al*. 1992). For example, Ehrenfeld (1970) noted that there is little, if any, benefit of returning a zoo-maintained population to its former habitat unless the habitat is restored and protected. As noted above, there is considerable uncertainty in the ability of artificial propagation to maintain a population or ESU in isolation over the long term. Although widely distributed salmonid artificial propagation facilities ,may seemingly decrease risks to an ESU's spatial structure, the reduction of spatial structure risks over the long term is largely determined by the existence of well distributed and interconnected natural habitat patches capable of sustaining naturally spawning populations.

The was general agreement among the workshop attendees that properly designed and operated artificial propagation programs can provide short-term benefits to an ESU's diversity during years of critically low natural abundance, or until habitat restoration efforts are completed. The potential benefit of artificial propagation to an ESU's diversity is extremely uncertain over the long-term for isolated hatchery programs with little or no integration of natural-origin fish. It is unavoidable that hatcheries remove salmonids from the natural environment during life-history stages where natural selection would otherwise exert a major influence on naturally produced progeny. In the absence of this natural selection, isolated hatchery stocks may be subject to little or no natural selection within the hatchery. Due to the artificial selective regime in hatcheries, the potential long-term benefits of artificial propagation to an ESU's diversity are uncertain. Over the long-term the selective regime in a hatchery would likely favor genes suitable for the hatchery environment, selecting for traits that are likely to be detrimental in the natural environment. Additionally, in the absence of natural selection to reinforce traits that are favorable in the natural environment, artificial propagation over the long term may permit the genetic drift of locally adapted life-history traits.

## 4. Overview of Workshop Discussion and Findings for Twenty-Three ESUs with Associated Artificial Propagation Programs

### 4.1 Oregon Coast coho ESU

The BRT concluded that the naturally spawned component of the Oregon Coast coho ESU is "likely to become endangered within the foreseeable future." The BRT found high risk in the productivity VSP category, and comparatively lower risk for the ESU's abundance, spatial structure, and diversity.

The SHIEER concluded that there are five artificial propagation programs that are no more than moderately diverged from the local natural populations in the ESU. These five hatchery programs are considered part of the Oregon Coast coho ESU (Table 2): the North Umpqua River (ODFW stock # 18), Cow Creek (ODFW stock # 37), Coos Basin (ODFW stock #37), Coquille River (ODFW stock # 44), and North Fork Nehalem River (ODFW stock # 32) coho hatchery programs. There were no dissenting opinions offered by the workshop attendees regarding the ESU membership of the above listed hatchery programs.

Four of the 19 natural populations in the Oregon Coast coho ESU are affected by the five hatchery programs considered part of the ESU. All of these hatchery programs are operated by the state of Oregon to provide harvest opportunities. Substantial changes in coho salmon propagation have occurred over the previous ten years to achieve a balance between obligations to help conserve coastal coho and to mitigate for habitat degradation, and maintain fishing opportunities. These changes include a dependence on local origin fish for broodstock, management actions to reduce straying (10% is the objective), and the cessation of stocking coho in five coastal rivers. Coastal coho stocking has decreased by 84% since 1993. These programs are not managed to contribute to the ESU's abundance, productivity, spatial structure, or diversity.

Although the within-ESU hatchery programs contribute to increasing the total abundance for 4 of the 19 ESU populations, the effect on the abundance of the ESU in-total is slight. In an attempt to avoid potentially adverse effects of naturally spawning hatchery fish on ESU natural populations, the state of Oregon manages these hatchery populations to limit the numbers of hatchery fish on the spawning grounds. The contribution of the within-ESU hatchery programs to the productivity of the ESU in-total is uncertain, however, given the low proportion of naturally spawning hatchery fish in the ESU any contribution is likely negligible. The artificial propagation programs in the ESU do little to mitigate risks to the ESU's productivity, the principal risk factor identified by the BRT. There is little to no effect of the within-ESU hatchery programs on the spatial structure of the ESU in-total, as most populations are not affected by artificial propagation. The spatial distribution of some natural populations, however, is negatively affected by the operation of hatchery facilities and weirs. There is little to no benefit of the Oregon Coast coho hatchery programs to the ESU's diversity. Those programs that incorporate natural fish into the broodstock are contributing to reducing past risks to the ESU's diversity posed by artificial propagation. Two out-of-ESU hatchery programs (the Salmon River (ODFW stock # 33) and Trask River (ODFW stock # 34) hatchery programs), however, do not incorporate natural fish into the broodstock and remain a threat to the ESU's diversity. The SHIEER concluded that the five artificial propagation programs in the ESU collectively provide a slight beneficial effect to the ESU's abundance, but provide neutral or uncertain effects to the ESU's productivity, spatial structure, and diversity. Informed by the BRT's findings (NMFS 2003b) and the SHIEER's assessment of the effects of artificial propagation programs on the viability of the ESU (NMFS 2004b), the workshop participants concluded that the Oregon Coast coho ESU in-total is "likely to become endangered in the foreseeable future." There were no dissenting views expressed concerning the extinction risk assessment of the Oregon Coast coho ESU in-total.

Table 4.1. Summary of Artificial Propagation Evaluation Workshop's findings for the Oregon Coast coho ESU.

| **VSP Criterion** | **Collective Impact of within-ESU Hatchery Programs on the VSP Risks for the Entire ESU** |
|---|---|
| Abundance | Slightly decreased risk |
| Productivity | Neutral or uncertain effect |
| Spatial structure | Neutral or uncertain effect |
| Diversity | Neutral or uncertain effect |
| **Extinction risk for the ESU in-total:** | **Artificial propagation programs do not substantially change the BRT's assessment of the ESU's extinction risk** ***The Oregon Coast coho ESU is likely to become endangered within the foreseeable future throughout all or a significant portion of its range*** |

## 4.2 Upper Columbia River spring-run chinook ESU

The BRT's assessment of overall extinction risk faced by the naturally spawned component of the Upper Columbia River spring-run chinook ESU was divided between "in danger of extinction" and "likely to become endangered within the foreseeable future," with a slight majority opinion that the ESU is "in danger of extinction." The BRT's assessment of risk for the four VSP categories reflects strong concerns regarding abundance and productivity, and comparatively less concern for the ESU's spatial structure and diversity.

The SHIEER concluded that there are six artificial propagation programs that are no more than moderately diverged from the local natural populations in the ESU. These six hatchery programs are considered part of the Upper Columbia River spring-run chinook ESU (Table 2): the Twisp River, Chewuch River, Methow Composite, Winthrop NFH, Chiwawa River, and White River spring-run chinook hatchery programs. There were no dissenting opinions offered by the workshop attendees regarding the ESU membership of the above listed hatchery programs.

The Entiat NFH operating in the Entiat River is not included in the ESU, and is intended to remain isolated from the local natural population. The within-ESU hatchery programs are conservation programs intended to contribute to the recovery of the ESU by increasing the abundance and spatial distribution of naturally spawned populations, while maintaining the genetic integrity among populations within the ESU. Three of the conservation programs incorporate local natural broodstock to minimize adverse genetic effects, and follow broodstock protocols guarding against the overcollection of the natural run. The remaining within-ESU hatchery programs are captive broodstock programs. These programs also adhere to strict protocols for the collection, rearing, maintenance, and mating of the captive brood populations. All of the six artificial propagation programs considered to be part of the ESU include extensive monitoring and evaluation efforts to continually evaluate the extent and implications of any genetic and behavioral differences that might emerge between the hatchery stocks and natural populations.

Genetic evidence suggests that the within-ESU programs remain closely related to the naturally-spawned populations and maintain local genetic distinctiveness among populations within the ESU. The captive broodstock programs may exhibit lower fecundity and younger average age-at-maturity compared to the natural populations from which they were derived. However, the extensive monitoring and evaluation efforts employed afford the adaptive management of any unintended adverse effects. Habitat Conservation Plans and binding mitigation agreements ensure that these programs will have secure funding and will continue operating into the future. These hatchery programs have undergone ESA Section 7 consultation to ensure that they do not jeopardize the continued existence of the ESU, and they have received ESA Sec. 10 permits for production through 2007. Annual reports and other specific information reporting requirements ensure that the terms and conditions as specified by NMFS are followed. These programs, through adherence to best professional practices, have not experienced disease outbreaks or other catastrophic losses.

Overall, the hatchery programs in the ESU have increased the total abundance of fish considered to be part of the ESU. Specifically, the two hatchery programs in the Wenatchee basin have contributed to reducing abundance risk. However, it is uncertain whether the four programs in the Methow basin provide a net benefit to abundance. The contribution of the within-ESU hatchery programs to the productivity of the ESU in-total is uncertain. The overall impact of the hatchery programs on the ESU's spatial structure is neutral.  The Wenatchee basin programs are managed to promote appropriate spatial structure, and likely reduce spatial structure risk in that basin.  The Methow basin hatchery programs, however, concentrate spawners near the hatchery facilities, altering population spatial structure and increasing vulnerability to catastrophic events.  Overall, within-ESU hatchery programs do not moderate risks to the ESU's diversity.  The Wenatchee basin programs do help preserve population diversity though the incorporation of natural-origin fish into broodstock.  The Methow basin programs, however, incorporate few natural fish as hatchery-origin fish predominate on the spawning grounds.  Additionally, the presence of out-of-ESU Carson stock chinook in the Methow basin remains a concern, although the stock is in the process of being terminated.  The out-of-ESU Entiat hatchery program is a source of significant concern to the ESU.  The Entiat stock may have introgressed significantly with, or replaced, the native spring-run chinook population.  The SHIEER concluded that although the six artificial propagation programs in the ESU collectively provide a slight beneficial effect to the ESU's abundance, they do not mitigate the risks identified by the BRT to the ESU's productivity, spatial structure, and diversity.  Informed by the BRT's findings (NMFS 2003b) and the SHIEER's assessment of the effects of artificial propagation programs on the viability of the ESU (NMFS 2004b), the workshop participants concluded that the Upper Columbia River spring-run chinook ESU in-total is "in danger of extinction."  There were no dissenting views expressed among workshop participants concerning the extinction risk of the Upper Columbia River spring-run chinook ESU in-total.  However, one workshop observer conceded that the risks to the VSP parameters for the ESU are not substantially reduced by the artificial propagation programs included in the ESU, but argued that the presence of these hatchery programs in the ESU substantially buffered against the  imminent risk of the ESU going extinct.  This view was not shared by the balance of the workshop attendees.  Another workshop observer pointed out that within the last ten years the Upper Columbia River spring-run chinook ESU nearly did go extinct, despite the fact that the within-ESU hatchery programs were in operation.

Table 4.2.  Summary of the Artificial Propagation Evaluation Workshop's findings for the Upper Columbia River spring-run chinook ESU.

| **VSP Criterion** | **Collective Impact of within-ESU Hatchery Programs on the VSP Risks for the Entire ESU** |
|---|---|
| Abundance | Slightly decreased risk |
| Productivity | Neutral or uncertain effect |
| Spatial structure | Neutral or uncertain effect |
| Diversity | Neutral or uncertain effect |
| **Extinction risk for the ESU in-total:** | **Artificial propagation programs do not substantially change the BRT's assessment of the ESU's extinction risk** ***The Upper Columbia spring-run chinook ESU is in danger of extinction throughout all or a significant portion of its range*** |

4.3 Hood Canal summer-run chum ESU

The majority opinion of the BRT was that the naturally spawned component of the Hood Canal summer-run chum ESU is "likely to become endangered within the foreseeable future," with a minority opinion that the ESU is "in danger of extinction." The BRT found high risks for each of the VSP categories.

The SHIEER concluded that there are eight artificial propagation programs that are no more than moderately diverged from the local natural populations in the ESU. These eight hatchery programs are considered part of the Hood Canal summer-run chum ESU (Table 2): the Quilcene NFH, Hamma Hamma Fish Hatchery, Lilliwaup Creek Fish Hatchery, Union River/Tahuya, Big Beef Creek Fish Hatchery, Salmon Creek Fish Hatchery, Chimacum Creek Fish Hatchery, and the Jimmycomelately Creek Fish Hatchery summer-run chum hatchery programs. There were no dissenting opinions offered by the workshop attendees regarding the ESU membership of the above listed hatchery programs.

Six of the eight hatchery programs are supplementation programs implemented to preserve and increase the abundance of native populations in their natal watersheds. These supplementation programs propagate and release fish into the Salmon Creek, Jimmycomelately Creek, Big Quilcene River, Hamma Hamma River, Lilliwaup Creek, and Union River watersheds. The remaining two programs use transplanted summer-run chum salmon from adjacent watersheds to reintroduce populations into Big Beef Creek and Chimacum Creek, where the native populations have been extirpated. Each of the hatchery programs includes research, monitoring, and evaluation activities designed to determine success in recovering the propagated populations to viable levels, and to determine the demographic, ecological, and genetic effects of each program on target and non-target salmonid populations. All the Hood Canal summer-run chum hatchery programs will be terminated after 12 years of operation.

The hatchery programs are benefiting the ESU's abundance by increasing total number of ESU fish, as well as by augmenting the total number of naturally spawning summer-run chum salmon. Several of the programs have likely prevented further population extirpations in the ESU. The contribution of the within-ESU hatchery programs to the productivity of the ESU in-total is uncertain. The hatchery programs are benefiting the ESU's spatial structure by increasing the spawning area utilized in several watersheds, and by increasing the geographic range of the ESU through reintroductions. These programs also provide benefits to the ESU's diversity. By bolstering total population sizes, the hatchery programs have likely stemmed adverse genetic effects for populations at critically low abundance levels. Additionally, measures have been implemented to maintain current genetic diversity, including the use of native broodstock and the termination of the programs after 12 years of operation to guard against long-term domestication effects. The SHIEER concluded that artificial propagation programs in the ESU presently provide a slight beneficial effect to the ESU's abundance, spatial structure, and diversity, but uncertain effects to the ESU's productivity. The long-term contribution of these programs after they are terminated is uncertain. Despite the current benefits provided by the comprehensive hatchery conservation efforts for Hood Canal summer-run chum, the ESU remains at low overall abundance with nearly half of historical populations extirpated. Informed by the BRT's findings (NMFS 2003b) and the

SHIEER's assessment of the effects of artificial propagation programs on the viability of the ESU (NMFS 2004b), the workshop participants concluded that the Hood Canal summer-run chum ESU in-total is "likely to become endangered in the foreseeable future." Observers in attendance from the Northwest Fisheries Science Center and the BRT expressed concern that the positive contributions of Hood Canal summer-run chum hatchery programs to the ESU's abundance, spatial structure, and diversity had been included in the BRT's considerations. However, the workshop participants concluded that the benefits attributable to the Hood Canal summer-run chum hatchery programs do not alter the BRT's extinction risk assessment. There were no dissenting views expressed concerning the workshop participants' assessment that the Hood Canal summer-run chum ESU in-total is "likely to become endangered within the foreseeable future."

Table 4.3. Summary of the Artificial Propagation Evaluation Workshop's findings for the Hood Canal summer-run chum ESU.

| **VSP Criterion** | **Collective Impact of within-ESU Hatchery Programs on the VSP Risks for the Entire ESU** |
|---|---|
| Abundance | Decreased risk |
| Productivity | Neutral or uncertain effect |
| Spatial structure | Decreased risk |
| Diversity | Decreased risk |
| **Extinction risk for the ESU in-total:** | **Artificial propagation programs do not substantially change the BRT's assessment of the ESU's extinction risk** ***The Hood Canal summer-run chum ESU is likely to become endangered in the foreseeable future throughout all or a significant portion of its range*** |

4.4 Central California Coast O. mykiss ESU

The majority opinion of the BRT was that the naturally spawned component of the Central California Coast O. mykiss ESU is "likely to become endangered within the foreseeable future", with a minority opinion that the ESU is "in danger of extinction." The BRT found moderately high risks for the abundance and productivity VSP risk categories, and comparatively less risk for the spatial structure and diversity categories.

The SHIEER concluded that there are two artificial propagation programs that are no more than moderately diverged from the local natural populations in the ESU. These two hatchery programs are considered part of the Central California Coast O. mykiss ESU (Table 2): the Don Clausen Fish Hatchery, and Kingfisher Flat Hatchery/Scott Creek (Monterey Bay Salmon and Trout Project) steelhead hatchery programs. There were no dissenting opinions offered by the workshop attendees regarding the ESU membership of the above listed hatchery programs.

One of these program is located in the northernmost river in the ESU (Don Clausen hatchery on the Russian River), while the other is located in the southern portion of the ESU (Monterey Bay Salmon and Trout Project on the Scott River) where the extinction risk for local populations is thought to be higher. The hatchery on the Russian

River is a relatively large-scale mitigation program which is primarily intended to support recreational fisheries for steelhead in this watershed. This program was established primarily with local broodstock, but has not integrated natural-origin fish into the broodstock since 2000, and is therefore isolated from the natural spawning component of the ESU. Escapement to the hatchery is substantial, but there are no estimates of overall Russian River O. mykiss abundance, nor are there any estimates of the contribution of hatchery-origin fish to overall abundance. The artificial propagation program on Scott Creek is much smaller than the Russian River program. It incorporates natural-origin fish from Scott Creek and nearby San Lorenzo Creek for broodstock and is currently operated for the purpose of restoring the local natural population.

Hatchery-origin steelhead from the Don Clausen hatchery program on the Russian River have been increasing in abundance for the past several years, but many fish return directly to the hatchery or are harvested and there is no information documenting the extent to which hatchery-origin fish spawn naturally. Though there is natural spawning of steelhead in the Russian River system, the abundance of spawners has not been documented. There is no information documenting whether the Monterey Bay Salmon and Trout Project program is increasing local abundance of natural steelhead, but the program was recently converted from one that supported a fishery to one that is attempting to restore the local natural population. Effects of these artificial propagation programs on productivity are uncertain and no efforts are currently underway to assess the effects of productivity on the naturally spawning component of the ESU or the ESU in-total. The Don Clausen hatchery population has been increasing in abundance and has a relatively high level of production, but it is managed to support a fishery rather than to augment naturally spawning local populations. Hatchery-origin steelhead from both programs generally occur in the same areas as natural origin fish and there is no information indicating that either program has resulted in an expanded distribution of the ESU in-total, thus effects to the ESU's spatial structure are likely neutral. The Don Clausen program uses only hatchery-origin fish for broodstock, and this is likely to lead to divergence of the hatchery stock from the local natural population, and may pose a risk to local populations. The Monterey Bay Salmon and Trout Program uses natural broodstock to minimize domestication effects and is operated to assist in the restoration of local stocks, however, it is uncertain to what extent the program serves to preserve genetic diversity in the ESU. The SHIEER concluded that the two artificial propagation programs in the ESU collectively provide a slight beneficial effect to the ESU's abundance, but neutral or uncertain effects to the ESU's productivity, spatial structure, and diversity. Informed by the BRT's findings (NMFS 2003b) and the SHIEER's assessment of the effects of artificial propagation programs on the viability of the ESU (NMFS 2004b), the workshop participants concluded that the Central California Coast O. mykiss ESU in-total is "likely to become endangered in the foreseeable future." There were no dissenting views expressed concerning the extinction risk of the Central California Coast O. mykiss ESU in-total.

Table 4.4. Summary of the Artificial Propagation Evaluation Workshop's findings for the Central California Coast O. mykiss ESU.

| **VSP Criterion** | **Collective Impact of within-ESU Hatchery Programs on the VSP Risks for the Entire ESU** |
|---|---|

| | |
|---|---|
| Abundance | Slightly decreased risk |
| Productivity | Neutral or uncertain effect |
| Spatial structure | Neutral or uncertain effect |
| Diversity | Neutral or uncertain effect |
| **Extinction risk for the ESU in-total:** | **Artificial propagation programs do not substantially change the BRT's assessment of the ESU's extinction risk** ***The Central California Coast O. mykiss ESU is likely to become endangered in the foreseeable future throughout all or a significant portion of its range*** |

### 4.5 Central California Coast coho ESU

The strong majority opinion of the BRT was that the naturally spawned component of the Central California Coast coho ESU was "in danger of extinction," with a minority opinion that the ESU is "likely to become endangered within the foreseeable future." The BRT found very high risks for the abundance, productivity, and spatial structure VSP parameters, and comparatively moderate risk with respect to the diversity VSP parameter.

The SHIEER concluded that there are four artificial propagation programs that are no more than moderately diverged from the local natural populations in the ESU. These four hatchery programs are considered part of the Central California Coast coho ESU (Table 2): the Don Clausen Fish Hatchery Captive Broodstock Program, Scott Creek/King Fisher Flats Conservation Program, Scott Creek Captive Broodstock Program, and the Noyo River Fish Station egg-take Program coho hatchery programs. There were no dissenting opinions offered by the workshop attendees regarding the ESU membership of the above listed hatchery programs.

The Noyo River program is an augmentation program located in the northern portion of the ESU which regularly incorporates local natural-origin fish into the broodstock and releases fish into the Noyo River watershed. The program has been in operation for over 50 years; however, the program has recently been discontinued. The Monterey Bay Salmon and Trout Project is an artificial propagation program that is operated as a conservation program designed to supplement the local natural population, located in the southern portion of the ESU (south of San Francisco) where natural populations are at the highest risk of extinction. Relatively small numbers of fish are spawned and released from this program on Scott Creek, but natural-origin fish are routinely incorporated into the broodstock. Recently, captive broodstock programs have been established for the Russian River and Scott Creek populations in order to preserve the genetic resources of these two naturally spawning populations and for use in future artificial propagation programs. Artificially propagated fish from these two captive broodstock programs will be outplanted in the Russian River and Scott Creek watersheds to supplement local natural populations. The Russian River program is integrated with a habitat restoration program designed to improve habitat conditions and subsequent survival for outplanted coho juveniles.

The three conservation hatchery programs are considered crucial to the recovery of this ESU, but it is unclear if they have had any beneficial effect on natural spawner abundance. The Noyo River program which had been operated for over 50 years is being terminated because it has not met CDFG's goal of increasing coho salmon abundance. Productivity of coho salmon in the Noyo River is thought to have been reduced or unaffected by artificial propagation in that watershed over the past 50 years. It is uncertain how effective the captive broodstock and rearing programs in the Russian River and Scott Creek will be in increasing productivity, but efforts in the Russian River are coupled with a major habitat restoration effort which may improve natural population productivity. The two captive broodstock programs will hopefully contribute to future abundance and improved spatial structure of the ESU, but outplanting has yet to be implemented so long term benefits are uncertain. The Monterey Bay Salmon and Trout Program is thought to be responsible for maintaining the presence of natural-origin coho salmon in Scott Creek which is at the southern extent of the ESU's range. Both of the captive broodstock programs, particularly the Scott Creek program, are serving as genetic repositories which serve to preserve the genome of the ESU, thereby reducing genetic diversity risks. The SHIEER concluded that the four artificial propagation programs in the ESU collectively provide a slight beneficial effect to the ESU's abundance and diversity, but neutral or uncertain effects to the ESU's productivity and spatial structure. A workshop observer from the BRT noted that these artificial propagation programs at best provide a genetic reserve for only two populations, representing a very small proportion of the ESU in-total. Informed by the BRT's findings (NMFS 2003b) and the SHIEER's assessment of the effects of artificial propagation programs on the viability of the ESU (NMFS 2004b), the workshop participants concluded that the Central California Coast coho ESU in-total is "in danger of extinction." There were no dissenting views expressed concerning the extinction risk assessment of the Central California Coast coho ESU in-total.

Table 4.5. Summary of the Artificial Propagation Evaluation Workshop's findings for the Central California Coast coho ESU.

| **VSP Criterion** | **Collective Impact of within-ESU Hatchery Programs on the VSP Risks for the Entire ESU** |
|---|---|
| Abundance | Slightly decreased risk |
| Productivity | Neutral or uncertain effect |
| Spatial structure | Neutral or uncertain effect |
| Diversity | Slightly decreased risk |
| **Extinction risk for the ESU in-total:** | **Artificial propagation programs do not substantially change the BRT's assessment of the ESU's extinction risk**<br>***The Central California Coast coho ESU is in danger of extinction throughout all or a significant portion of its range*** |

4.6 Ozette Lake sockeye ESU

The majority opinion of the BRT was that the naturally spawned component of the Ozette Lake sockeye ESU is "likely to become endangered within the foreseeable future," with the minority being split between "in danger of extinction" and "not in danger of extinction or likely to become endangered within the foreseeable future. The BRT expressed moderately high concern for each of the VSP risk categories

The SHIEER concluded that there are two artificial propagation programs that are no more than moderately diverged from the local natural population in the ESU. These two hatchery programs are considered part of the Ozette Lake sockeye ESU (Table 2): the Umbrella Creek and Big River sockeye hatchery programs. There were no dissenting opinions offered by the workshop attendees regarding the ESU membership of the above listed hatchery programs.

The two artificial propagation programs, operated by the Makah Tribe, are derived from native broodstock and have the primary objective of establishing viable sockeye salmon spawning aggregations in two Ozette Lake tributaries where spawning has not been observed for many decades, if ever. The programs include research, monitoring, and evaluation activities designed to determine success in bringing the targeted tributary populations to viable levels, and to determine the demographic, ecological, and genetic effects on the and non-target (i.e., Ozette Lake beach) spawning aggregations The Makah programs will terminate after 12 years of operation

The Makah supplementation programs at Umbrella Creek and Big River have increased the abundance of natural spawners and natural-origin sockeye in the Ozette Lake tributaries. However, it is unknown whether these tributaries were historically spawning habitat. The programs (by design) have not increased the abundance of natural spawners or natural-origin beach spawners in Ozette Lake. Despite the relative increases in abundance due to the supplementation programs, the ESU's total abundance remains small for a single sockeye population. The contribution of artificial propagation to the ESU's productivity is uncertain. Only since 2000 have the hatchery returns been sufficient to meet the programs' broodstock goals. The Makah programs at present serve as an important genetic reserve in face of the continuing loss of Ozette Lake beach spawning habitat. The reintroduction of spawners to Ozette Lake tributaries reduces risks to the ESU's spatial structure. However, the isolation of the hatchery programs and their likely adaptation to tributary habitats may cause the tributary spawning aggregations to diverge from the founding beach spawning aggregations. The SHIEER concluded that although the programs have a beneficial effect on the ESU's abundance and spatial structure, they have neutral or uncertain effects on the ESU's productivity and diversity. A workshop observer from the BRT cautioned that any beneficial effects on the ESU's abundance are either recent or predicted for the future. Until four years ago the Makah hatchery programs were taking natural fish for broodstock from the Ozette Lake beach spawning sites, such that in the past these hatchery programs may have increase risks to the ESU's abundance. Two workshop participants also noted that the selective regime of the Ozette Lake tributaries is likely quite different from that of the lake beach spawning sites. The two hatchery programs may be selecting for a different type of Ozette Lake sockeye by isolating tributary and beach spawners. Another workshop observer from the BRT argued that the BRT had already considered the presence of naturally spawning hatchery fish in the Ozette Lake tributaries when it evaluated risks to the ESU's spatial structure. Accordingly, the SHIEER's assessment of a decrease in risk to the ESU's spatial structure from the Makah hatchery programs may represent "double counting" of the benefit. Informed by the BRT's findings (NMFS 2003b) and the SHIEER's assessment of the effects of artificial propagation programs on the viability of the ESU

(NMFS 2004b), the workshop participants concluded that the Ozette Lake sockeye ESU in-total is "likely to become endangered in the foreseeable future." There were no dissenting views expressed concerning the extinction risk assessment of the Ozette Lake sockeye ESU in-total.

Table 4.6. Summary of the Artificial Propagation Evaluation Workshop's findings for the Ozette Lake sockeye ESU.

| **VSP Criterion** | **Collective Impact of within-ESU Hatchery Programs on the VSP Risks for the Entire ESU** |
|---|---|
| Abundance | Decreased risk |
| Productivity | Neutral or uncertain effect |
| Spatial structure | Decreased risk |
| Diversity | Neutral or uncertain effect |
| **Extinction risk for the ESU in-total:** | **Artificial propagation programs do not substantially change the BRT's assessment of the ESU's extinction risk** ***The Ozette Lake sockeye ESU is likely to become endangered within the foreseeable future throughout all or a significant portion of its range*** |

4.7 Puget Sound chinook ESU

The strong majority opinion of the BRT was that the naturally spawned component of the Puget Sound chinook ESU is "likely to become endangered within the foreseeable future," with a minority opinion that the ESU is in "not in danger of extinction or likely to become endangered within the foreseeable future." The BRT found moderately high risks for all VSP categories.

The SHIEER concluded that there are twenty-two artificial propagation programs that are no more than moderately diverged from the local natural populations in the ESU. These twenty-two hatchery programs are considered part of the Puget Sound chinook ESU (Table 2): the Kendal Creek Hatchery, Marblemount Hatchery (fall, spring yearlings, spring subyearlings, and summer run), Harvey Creek Hatchery, Whitehorse Springs Pond, Wallace River Hatchery (yearlings and subyearlings), Tulalip Bay, Soos Creek Hatchery, Icy Creek Hatchery, Keta Creek Hatchery, White River hatchery, White Acclimation Pond, Hupp Springs hatchery, Voights Creek Hatchery, Diru Creek, Clear Creek, Kalama Creek, Dungeness/Hurd Creek Hatchery, Elwha Channel Hatchery chinook hatchery programs. A workshop observer questioned why the Issaquah hatchery, determined by the SSHAG Report (NMFS 2003a) to be no more than moderately divergent from the local natural populations, was not included in the ESU. It was explained that the Issaquah hatchery stock had been isolated from its founding Green River stock, and information from a Washington State co-manager indicates that the hatchery has diverged from its founding population. The SHIEER notes six additional hatchery stocks where its conclusions differ from those of the SSHAG Report. There were no other dissenting opinions offered by the workshop attendees regarding the ESU membership of the above listed hatchery programs.

Eight of the twenty-two within-ESU hatchery programs are directed at conservation, and are specifically implemented to preserve and increase the abundance of native populations in their natal watersheds where habitat needed to sustain the populations naturally at viable levels has been lost or degraded. Each of these conservation hatchery programs includes research, monitoring, and evaluation activities designed to determine success in recovering the propagated populations to viable levels, and to determine the demographic, ecological, and genetic effects of each program on target and non-target salmonid populations. The remaining programs considered to be part of the ESU are operated primarily for harvest augmentation purposes (some of which also function as research programs) using transplanted within-ESU Green River origin stock as broodstock.

The conservation and hatchery augmentation programs collectively have increased the total abundance of the ESU. The conservation programs have increased the abundance of naturally spawning chinook, and likely have reduced abundance risks for these populations. The large numbers of chinook produced by the harvest augmentation programs, however, have resulted in considerable numbers of strays. Any potential benefits from these programs by augmenting total fish abundance likely are offset by increased ecological and genetic risks. There is no evidence that any of the twenty-two within-ESU hatchery programs have contributed to increased abundances of natural-origin chinook, despite decades of infusing natural spawning areas with hatchery fish. The contribution of the within-ESU hatchery programs to the productivity of the ESU in-total is uncertain. Four programs are planting hatchery fish above impassible dams, providing some benefit to the ESU's spatial structure. However, the ongoing practice of transplanting stocks within the ESU and incorporating little natural local-origin broodstock continues to pose significant risks to the ESU's spatial structure and diversity. The conservation hatchery programs function to preserve remaining genetic diversity, and likely have prevented the extirpation of several populations. Benefits to the ESU's diversity from the conservation hatchery programs are largely offset by threats to diversity from the wide-use of transplanted Green River hatchery fish, and the risk of straying and the homogenization of the remaining genetic diversity in the ESU. Among the harvest augmentation programs are yearling chinook release programs. Yearling chinook programs may be harmful to local natural-origin populations due to increased risks of predation and the reduction of within-population diversity. The SHIEER concluded that the twenty-two artificial propagation programs in the ESU collectively provide a slight beneficial effect to the ESU's abundance and spatial structure, but neutral or uncertain effects to the ESU's productivity and diversity. A workshop observer from the BRT underscored that the principal risks identified by the BRT were in the productivity and diversity categories where ESU artificial propagation efforts have a neutral or uncertain effect. Informed by the BRT's findings (NMFS 2003b) and the SHIEER's assessment of the effects of artificial propagation programs on the viability of the ESU (NMFS 2004b), the workshop participants concluded that Puget Sound chinook ESU in-total is "likely to become endangered in the foreseeable future." There were no dissenting views expressed concerning the extinction risk assessment of the Puget Sound chinook ESU in-total.

Table 4.7. Summary of the Artificial Propagation Evaluation Workshop's findings for the Puget Sound chinook ESU.

| **VSP Criterion** | **Collective Impact of within-ESU Hatchery Programs on the VSP Risks for the Entire ESU** |
|---|---|
| Abundance | Decreased risk |
| Productivity | Neutral or uncertain effect |
| Spatial structure | Decreased risk |
| Diversity | Neutral or uncertain effect |
| **Extinction risk for the ESU in-total:** | **Artificial propagation programs do not substantially change the BRT's assessment of the ESU's extinction risk** ***The Puget Sound chinook ESU is likely to become endangered within the foreseeable future throughout all or a significant portion of its range*** |

4.8 Lower Columbia River coho ESU

The strong majority opinion of the BRT was that the naturally spawned component of the Lower Columbia River coho ESU is "in danger of extinction." The minority opinion was that the ESU is "likely to become endangered within the foreseeable future." The BRT found extremely high risks for each of the VSP categories.

The SHIEER concluded that there are twenty-one artificial propagation programs that are no more than moderately diverged from the extant local natural populations in the ESU. These twenty-one hatchery programs are considered part of the Lower Columbia River coho ESU (Table 2): the Grays River, Sea Resources Hatchery, Peterson Coho Project, Big Creek hatchery, Astoria High School (STEP) Coho Program, Elochoman Type-S Coho Program, Elochoman Type-N Coho Program, Cathlamet High School FFA Type-N Coho Program, Cowlitz Type-N Coho Program in the Upper and Lower Cowlitz Rivers, Cowlitz Game and Anglers Coho Program, Friends of the Cowlitz Coho Program, North Fork Toutle River Hatchery, Lewis River Type-N Coho Program, Lewis River Type-S Coho Program, Fish First Wild Coho Program, Fish First Type-N Coho Program, Syverson Project Type-N Coho Program, Sandy Hatchery, and the Bonneville/Cascade/Oxbow complex coho hatchery programs.

There was considerable discussion regarding the level of homogenization and divergence in the Lower Columbia River coho ESU due to past hatchery practices. Of 23 historical populations, there are only two extant naturally spawning populations (in the Sandy and Clackamas Rivers). Past artificial propagation efforts imported out-of-ESU fish for broodstock, generally did not mark hatchery fish, mixed broodstocks derived from different local populations, and transplanted stocks among basins throughout the ESU. The result is that the hatchery stocks considered to be part of the ESU represent a homogenization of populations. There is considerable difficulty in evaluating whether Lower Columbia River coho hatchery programs exhibit more than moderate divergence from the ESU, given the paucity of *local* natural populations with which to compare. Although the genetic population structure within the ESU has been blurred relative to historical conditions, the Lower Columbia River coho ESU remains distinct from other coho ESUs. Despite the loss of genetic diversity, the hatchery programs considered to be part of the ESU represent a substantial proportion of the remaining genetic resources in the ESU, and preserve important life-history distinctions within the ESU. Assessments of the degree of divergence were inferred on the basis of whether a given hatchery stock was founded from local natural broodstock, the level of inter-basin transfers of broodstock, and life-history traits exhibited by the hatchery stock relative to what is believed to be the historical condition. Although there was much discussion by the workshop attendees regarding the historical homogenization of populations and the level of genetic diversity remaining in the ESU, no dissenting opinions were expressed regarding the ESU membership of the above listed hatchery programs.

All of the twenty-one hatchery programs included in the Lower Columbia River coho ESU are designed to produce fish for harvest, with two small programs designed to also augment the natural spawning populations in the Lewis River basin. Artificial propagation in this ESU continues to represent a threat to the genetic, ecological, and behavioral diversity of the ESU. Several risks posed by artificial propagation have recently begun to be addressed by improvements in hatchery practices. Out-of-ESU broodstock is no longer used, near 100% marking of hatchery fish is employed to afford improved monitoring and evaluation of broodstock and (hatchery- and natural-origin) returns. However, many of the within-ESU hatchery programs do not adhere to best hatchery practices. Eggs are often transferred among basins in an effort to meet individual program goals, further compromising the ESU's spatial structure and diversity. Programs may utilize broodstock that does not reflect the life history that was historically present in a given basin, limiting the potential for artificial propagation to establish locally adapted naturally spawning populations. Many programs lack Hatchery and Genetic Management Plans that establish escapement goals appropriate for the natural capacity of each basin, and that identify goals for the incorporation of natural-origin fish into the broodstock.

At present, the within-ESU hatchery programs significantly increase the abundance of the ESU in-total. Without adequate long-term monitoring, it is unknown the extent to which there may be natural spawning outside of the Sandy and Clackamas River populations. The contribution of the within-ESU hatchery programs to the productivity of the ESU in-total is uncertain. The hatchery programs are widely distributed throughout the Lower Columbia River, reducing the spatial distribution of risk to catastrophic events. Additionally, reintroduction programs in the Upper Cowlitz River may provide additional reduction of risks to the ESU's spatial structure. As mentioned above, the majority of the ESU's genetic diversity exists in the hatchery programs. Although these programs have the potential of preserving historical local adaptation and behavioral and ecological diversity, the manner in which these potential genetic resources are presently being managed poses significant risks to the diversity of the ESU in-total. The SHIEER concluded that the twenty-one artificial propagation programs in the ESU collectively reduce risks to the ESU's abundance and spatial structure, provide uncertain benefits to the ESU's productivity, and pose risks to the ESU's diversity. The weight of opinion of the workshop participants was that artificial propagation in the Lower Columbia River coho ESU mitigates the immediacy of extinction risk in the short-term, but is of uncertain contribution in the long term. However, two workshop observers disagreed with this assessment. These workshop observers argued that the ESU is genetically homogenized, and 97% of the ESU is composed of hatchery fish produced by hatchery programs that are widely distributed throughout the Lower Columbia River with a demonstrated record of producing large abundances of hatchery fish. Based on these observations they argued that the Lower Columbia River coho ESU is not in danger of extinction or likely to become endangered in the foreseeable future. The workshop participants and the balance of the workshop observers did not agree with this opinion. Over the long term, reliance on the continued operation of these hatchery programs was deemed risky. Several Lower Columbia River coho hatchery programs have been terminated, and there is the prospect of additional closures in the future. With each hatchery closure, any potential benefits to the ESU's abundance and spatial structure are reduced. Risks of operational failure, disease, and environmental catastrophes further complicate assessments of hatchery contributions to the ESU's viability over the long term. Additionally, the two extant naturally spawning populations in the ESU were described by the BRT as being "in danger of extinction." Accordingly, it is likely that the Lower Columbia River coho ESU may exist in hatcheries only within the foreseeable future. It is uncertain whether the isolated hatchery programs considered to be part of the ESU can persist over the long term without the incorporation of natural-origin fish into the broodstock. Although there are examples of salmonid hatchery programs having been in operation for relatively long periods of time, these programs have not existed in complete isolation. Long-lived hatchery programs historically required infusions of wild fish in order to meet broodstock goals. The long-term sustainability of such isolated hatchery programs is unknown. It is uncertain whether the Lower Columbia River coho isolated hatchery programs are capable of mitigating risks to the ESU's viability into the foreseeable future. In isolation, these programs may also become more than moderately diverged from the evolutionary legacy of the ESU, and hence no longer merit inclusion in the ESU. Under either circumstance, the ability of artificial propagation to buffer the immediacy of extinction risk over the long-term is uncertain. Informed by the BRT's findings (NMFS 2003b) and the SHIEER's assessment of the effects of artificial propagation programs on the viability of the ESU (NMFS 2004b), the workshop participants concluded that the within-ESU hatchery programs buffer the immediacy of the BRT's assessment of extinction risk, finding that the Lower Columbia River coho ESU in-total is "likely to become endangered in the foreseeable future." There were no dissenting views among the workshop participants concerning the extinction risk of the Lower Columbia River coho ESU in-total.

Table 4.8. Summary of the Artificial Propagation Evaluation Workshop's findings for the Lower Columbia River coho ESU.

| **VSP Criterion** | **Collective Impact of within-ESU Hatchery Programs on the VSP Risks for the Entire ESU** |
|---|---|
| Abundance | Decreased risk |
| Productivity | Neutral or uncertain effect |
| Spatial structure | Decreased risk |
| Diversity | Neutral or uncertain effect |
| **Extinction risk for the ESU in-total:** | **Artificial propagation programs reduce the immediacy of the extinction risk assessed by the BRT for the two extant** |

| | |
|---|---|
| | **natural populations in the ESU.**<br>***The Lower Columbia River coho ESU is likely to become endangered within the foreseeable future throughout all or a significant portion of its range*** |

4.9 Sacramento River winter-run chinook ESU

The majority opinion of the BRT was that the naturally spawned component of the Sacramento winter-run chinook ESU is "in danger of extinction, " with a minority opinion that the ESU is "likely to become endangered within the foreseeable future." The BRT found extremely high risks for each of the four VSP risk categories.

The SHIEER concluded that there are two artificial propagation programs that are no more than moderately diverged from the local natural populations in the ESU. These hatchery programs are considered part of the Sacramento River winter-run chinook ESU (Table 2): winter-run chinook from the Livingston Stone National Fish Hatchery (NFH), and winter run chinook in a captive broodstock program maintained at Livingston Stone NFH and the University of California Bodega Marine Laboratory. There were no dissenting opinions offered by the workshop attendees regarding the ESU membership of the above listed hatchery programs.

The Livingston Stone NFH and captive broodstock programs have been operated for conservation purposes since the early 1990's. The Livingston Stone artificial propagation program was established to supplement the abundance of the naturally spawning winter-run chinook population, and thereby assist in its population growth and recovery. The captive broodstock program was established in the early 1990s when the naturally spawning population was at critically low levels (less than 200 spawners), in order to preserve the ESU's remaining genetic resources and to establish a reserve for potential use in the artificial propagation program. Because of increased natural escapement over the last several years, consideration is being given to terminating the captive broodstock program.

Spawning escapement of Sacramento River winter-run chinook has increased since the inception of the artificial propagation program, and artificially propagated fish may account for up to 10 percent of the total number of fish spawning naturally in a given year. Improvements in freshwater habitat conditions, harvest management, as well as improved ocean conditions, however, are thought to be the major factors responsible for the increased abundance of the ESU since the early 1990s. Effects on productivity are uncertain, but studies are underway to assess the effect of artificial propagation on fitness and productivity of artificially propagated fish. Although the abundance of spawners has increased, in part due to artificial propagation, the spatial distribution of spawners has not expanded. The primary reason is that the naturally spawning population is artificially maintained by cool water releases from Shasta/Keswick dams and the spatial distribution of spawners is largely governed by annual variability in the flow regime and the ability of the Central Valley Project to manage water temperatures in the upper Sacramento River. A second naturally spawning population is considered critical to the long-term viability of this ESU and plans are underway to eventually establish a second population in the upper Battle Creek watershed using the artificial propagation program as a source of fish, but the program has yet to be implemented because of the need to complete habitat restoration efforts in that watershed. The artificial propagation program has contributed to maintaining diversity of the ESU through careful use of spawning protocols and other tools that maximize genetic diversity of propagated fish and minimize impacts on naturally spawning populations. In addition, the artificial propagation and captive broodstock programs collectively serve as a genetic repository which serves to preserve the genome of the ESU. The SHIEER concluded that the artificial propagation programs in the ESU collectively benefit the ESU's abundance and diversity, but have neutral or uncertain effects on the ESU's productivity and spatial structure. Informed by the BRT's findings (NMFS 2003b) and the SHIEER's assessment of the effects of artificial propagation programs on the viability of the ESU (NMFS 2004b), the workshop participants concluded that the Sacramento River winter-run chinook ESU in-total is "in danger of extinction" There were no dissenting views expressed concerning the extinction risk assessment of the Sacramento River winter-run chinook ESU in-total.

Table 4.9. Summary of the Artificial Propagation Evaluation Workshop's findings for the Sacramento River winter-run chinook ESU.

| **VSP Criterion** | **Collective Impact of within-ESU Hatchery Programs on the VSP Risks for the Entire ESU** |
|---|---|
| Abundance | Decreased risk |
| Productivity | Neutral or uncertain effect |
| Spatial structure | Neutral or uncertain effect |
| Diversity | Decreased risk |
| **Extinction risk for the ESU in-total:** | **Artificial propagation programs do not substantially change the BRT's assessment of the ESU's extinction risk** ***The Sacramento River winter-run chinook ESU is in danger of extinction throughout all or a significant portion of its range*** |

### 4.10 California Coastal chinook ESU

The majority opinion of the BRT was that the naturally spawned component of the California Coastal chinook ESU is "likely to become endangered within the foreseeable future," with a minority opinion that the naturally spawned component of the ESU is "in danger of extinction." The BRT found moderately high risks for all VSP risk categories, and underscored a strong concern due to the paucity of information and the resultant uncertainty generated in evaluating the ESU's viability.

The SHIEER concluded that there are seven artificial propagation programs that are no more than moderately diverged from the local natural populations in the ESU. These seven hatchery programs are considered part of the California Coastal chinook ESU (Table 2): the Humboldt Fish Action Council (Freshwater Creek), Yager Creek, Redwood Creek, Hollow Tree, Van Arsdale Fish Station, Mattole Salmon Group, and Mad River Hatchery fall-run chinook hatchery programs. There were no dissenting opinions offered by the workshop attendees regarding the ESU membership of the above listed hatchery programs.

Five of the within-ESU hatchery programs (Freshwater Creek, Yager Creek, Redwood Creek, Hollow Tree, Mattole River Salmon Group, and Mad River Hatchery) are relatively small programs with production goals of less than 80,000 fish that have been operated for restoration purposes for more than 20 years. Because of State funding limitations, it is likely that these programs will be terminated after 2004. These programs are small-scale supplementation facilities operated by local groups or companies in cooperation with the California Department of Fish and Game (CDFG) under its cooperative hatchery program. The Van Arsdale Fish Station has been operated for over 30 years by CDFG for supplementation purposes in the upper Eel River. Because of State funding limitations, the operations at the Station were terminated in 2003. The seven within-ESU hatchery programs are primarily located in the northern portion of the ESU's range, and most are in the Eel River Basin.

There have been no demonstrable increases in natural abundance from the five cooperative hatchery programs, with the possible exception of increased abundance in the Freshwater Creek natural population and as a result of the rescue and rearing activities by the Mattole Salmon Group. The lack of observed abundance increases is, in part, due to the extremely limited monitoring of natural population in the watersheds where the hatchery programs are located. No efforts have been undertaken to assess the productivity of hatchery-produced fish or to assess the effects of hatchery-produced fish on the productivity of natural populations. The seven hatchery populations in this ESU are primarily located in the northern portion of the ESU's range and overlap with natural origin fish populations. With the exception of Freshwater Creek, where local distribution may have expanded in association with the recent increases in the natural population, there are no demonstrable beneficial effects on spatial structure. The five cooperative programs use only natural-origin fish as broodstock and mark all production with an adipose fin clip to minimize adverse genetic effects on the local natural populations.

The SHIEER concluded that the artificial propagation programs included in the ESU collectively provide neutral or uncertain effects to the ESU's abundance, productivity, spatial structure, and diversity. Informed by the BRT's findings (NMFS 2003b) and the SHIEER's assessment of the effects of artificial propagation programs on the viability of the ESU (NMFS 2004b), the workshop participants concluded that the California Coastal chinook ESU in-total is "likely to become endangered in the foreseeable future." There were no dissenting views expressed concerning the extinction risk assessment of the California Coastal chinook ESU in-total

Table 4.10. Summary of the Artificial Propagation Evaluation Workshop's findings for the California Coastal chinook ESU.

| **VSP Criterion** | **Collective Impact of within-ESU Hatchery Programs on the VSP Risks for the Entire ESU** |
|---|---|
| Abundance | Neutral or uncertain effect |
| Productivity | Neutral or uncertain effect |
| Spatial structure | Neutral or uncertain effect |
| Diversity | Neutral or uncertain effect |
| **Extinction risk for the ESU in-total:** | **Artificial propagation programs do not substantially change the BRT's assessment of the ESU's extinction risk** |

| | |
|---|---|
| | ***The California Coastal chinook ESU is likely to become endangered within the foreseeable future throughout all or a significant portion of its range*** |

4.11 Northern California O. mykiss ESU

The majority opinion of the BRT was that the naturally spawned component of the Northern California O. mykiss ESU is "likely to become endangered within the foreseeable future," with a minority opinion split between "in danger of extinction" and "not in danger of extinction or likely to become endangered within the foreseeable future." The BRT found high risk for the abundance VSP category, moderately high risk for the ESU's productivity, and comparatively lower risk for the ESU's spatial structure and diversity.

The SHIEER concluded that there are two artificial propagation programs that are no more than moderately diverged from the local natural populations in the ESU. These two hatchery programs are considered part of the Northern California O. mykiss ESU (Table 2): the Yager Creek Hatchery, and North Fork Gualala River Hatchery (Gualala River Steelhead Project) steelhead hatchery programs. There were no dissenting opinions offered by the workshop attendees regarding the ESU membership of the above listed hatchery programs.

The two within-ESU artificial propagation programs are very small ventures aimed at augmenting local steelhead abundance, and both were in operation for over two decades. The Yager Creek hatchery has not been in operation for the past few years and there are currently no plans to reopen it. The Gualala River Project has terminated the hatchbox portion of its operation, but is continuing with a juvenile rescue and rearing program. The workshop concluded that, at present, there are no hatchery programs active in this ESU.

Both programs may have increased local natural population abundance to a limited degree in the past, but with the termination of the artificial propagation activities in both programs' future, any benefits to the ESU's abundance are unlikely to continue. Effects on the ESU's productivity are uncertain, but continuation of the rescue and rearing program by the Gualala River project may provide some limited benefits locally through the salvage of fish that would otherwise be lost from the population. There is no information to assess whether either program had any effect on the ESU's spatial structure, but because of their relatively small size it is unlikely to have had much effect. Past operations at both hatchery facilities used local stock and incorporated only local natural origin fish in the broodstock. Thus adverse effects on local population diversity were minimized. The juvenile rescue and rearing program operated by the Gualala River project, although technically not an artificial propagation program, rescues up to 15,000 fish of all year classes in some years. Thus it can serve to preserve local genetic diversity that would otherwise be lost due to adverse habitat conditions. The SHIEER concluded that the two artificial propagation programs in the ESU are presently inactive, providing negligible benefits to the ESU's abundance, productivity, spatial structure, and diversity. Informed by the BRT's findings (NMFS 2003b) and the SHIEER's assessment of the effects of artificial propagation programs on the viability of the ESU (NMFS 2004b), the workshop participants concluded that the Northern California O. mykiss ESU in-total is "likely to become endangered in the foreseeable future." There were no dissenting views expressed concerning the extinction risk assessment of the Northern California O. mykiss ESU in-total.

Table 4.11. Summary of the Artificial Propagation Evaluation Workshop's findings for the Northern California O. mykiss ESU.

| **VSP Criterion** | **Collective Impact of within-ESU Hatchery Programs on the VSP Risks for the Entire ESU** |
|---|---|
| Abundance | Neutral or uncertain effect |
| Productivity | Neutral or uncertain effect |
| Spatial structure | Neutral or uncertain effect |
| Diversity | Neutral or uncertain effect |
| **Extinction risk for the ESU in-total:** | **Artificial propagation programs do not substantially change the BRT's assessment of the ESU's extinction risk** ***The Northern California O. mykiss ESU is likely to become endangered within the foreseeable future throughout all or a significant portion of its range.*** |

4.12 California Central Valley O. mykiss ESU

The majority opinion of the BRT was that the naturally spawned component of the California Central Valley O. mykiss ESU is "in danger of extinction." The minority opinion was that the naturally spawned component of the ESU is "likely to become endangered within the foreseeable future." The BRT found high risk for the abundance, productivity, and spatial structure VSP categories, and moderately high risk for the diversity category.

The SHIEER concluded that there are two artificial propagation programs that are no more than moderately diverged from the local natural populations in the ESU. These two hatchery programs are considered part of the California Central Valley O. mykiss ESU (Table 2): the Coleman NFH, and Feather River Hatchery steelhead hatchery programs. There were no dissenting opinions offered by the workshop attendees regarding the ESU membership of the above listed hatchery programs.

Both within-ESU hatchery programs are located in the Sacramento River basin and are large-scale mitigation facilities intended to support recreational fisheries for steelhead rather than to supplement naturally spawning populations. The Coleman National Fish Hatchery is located on Battle Creek which is a tributary in the upper Sacramento River. The program has been in operation for several decades and has a production goal of 600,000 smolts per year. Broodstock was originally derived from local or nearby Sacramento River stocks and all hatchery production is marked to facilitate harvest management and minimize impacts on natural origin fish. The natural population of O. mykiss in Battle Creek is integrated with the hatchery population, though the hatchery bypasses natural origin fish into the upper portion of the watershed above the hatchery. The Feather River Hatchery is located on the Feather River which is a major tributary in the upper Sacramento River basin. The program has also been operated for several decades and has a production goal of 400,000 smolts per year. Broodstock was originally derived from local or nearby stocks and all hatchery production is marked to allow harvest and also minimize impacts on natural origin fish. The natural population in the Feather River is integrated with the hatchery population.

Both the Coleman NFH and Feather River hatchery programs have increased abundance of fish in the ESU in-total; however, both programs are operated to support recreational harvest rather than to supplement natural spawning populations. Thus, much of the production is targeted for harvest and for use as broodstock, and the contribution to naturally spawning populations is uncertain. In the future, Coleman NFH may use some hatchery fish as part of an effort to supplement steelhead production in Upper Battle Creek above the hatchery. Effects on productivity are uncertain, but the Coleman NFH program is conducting a study to evaluate hatchery origin steelhead productivity relative to natural origin fish in Battle Creek. There is limited spawning habitat in both the Feather River and lower Battle Creek, so it is possible that high returns of hatchery fish to these watersheds will compete with local natural origin spawners for habitat, thereby reducing overall productivity. The Feather River hatchery program does not affect the ESU's spatial structure, however, the Coleman NFH program may have some limited beneficial effects in the future. The hatchery currently passes all natural origin fish into the upper Battle Creek watershed, but may supplement this with hatchery origin fish in coordination with ongoing restoration efforts in upper Battle Creek. Effects of these programs on the ESU's diversity are uncertain, but both programs incorporate natural origin fish into the broodstock to minimize divergence from naturally spawning local populations. The available genetic information suggests that both hatchery populations are genetically similar to natural origin fish in the upper Sacramento River basin.

The SHIEER concluded that the two artificial propagation programs in the ESU collectively provide a slight beneficial effect to the ESU's abundance, but neutral or uncertain effects to the ESU's productivity, spatial structure, and diversity. Informed by the BRT's findings (NMFS 2003b) and the SHIEER's assessment of the effects of artificial propagation programs on the viability of the ESU (NMFS 2004b), the workshop participants concluded that the California Central Valley O. mykiss ESU in-total is "in danger of extinction." There were no dissenting views expressed concerning the extinction risk assessment of the California Central Valley O. mykiss ESU in-total.

Table 4.12. Summary of the Artificial Propagation Evaluation Workshop's findings for the California Central Valley O. mykiss ESU.

| **VSP Criterion** | **Collective Impact of within-ESU Hatchery Programs on the VSP Risks for the Entire ESU** |
|---|---|
| Abundance | Slightly decreased risk |
| Productivity | Neutral or uncertain effect |
| Spatial structure | Neutral or uncertain effect |
| Diversity | Neutral or uncertain effect |
| **Extinction risk for the ESU in-total:** | **Artificial propagation programs do not substantially change the BRT's assessment of the ESU's extinction risk** ***The California Central Valley O. mykiss ESU is in danger of*** |

| | |
|---|---|
| | ***extinction throughout all or a significant portion of its range.*** |

4.13 Southern Oregon/Northern California Coast coho ESU

The strong majority opinion of the BRT was that the naturally spawned component of the Southern Oregon/Northern California Coast coho ESU is "likely to become endangered within the foreseeable future," with a minority opinion that the ESU is "in danger of extinction," and a slight minority concluding that the ESU is "not in danger of extinction or likely to become endangered within the foreseeable future." The BRT found moderately high risks for abundance and productivity VSP categories, with comparatively lower risk for spatial structure and diversity.

The SHIEER concluded that there are three artificial propagation programs that are no more than moderately diverged from the local natural populations in the ESU. These hatchery programs are considered part of the Southern Oregon/Northern California Coast coho ESU (Table 2): the Cole Rivers Hatchery (ODFW stock # 52), Trinity River Hatchery, and Iron Gate Hatchery coho hatchery programs. There were no dissenting opinions offered by the workshop attendees regarding the ESU membership of the above listed hatchery programs. The Rogue River hatchery in Oregon and the Trinity River and Iron Gate hatcheries (Klamath River) in California are all mitigation programs designed to produce fish for harvest, but they integrate naturally produced coho salmon into the broodstock in an attempt to minimize the genetic effects of returning hatchery adults that spawn naturally. All three programs have been in operation for several decades with smolt production goals ranging from 75,000 to 500,000 fish.

Abundance of the ESU in-total has been increased as a result of these artificial propagation programs, particularly in the Rogue and Trinity Rivers. In the Rogue River, hatchery origin fish have averaged approximately half of the returning spawners over the past 20 years. In the Trinity River, most naturally spawning fish are thought to be of hatchery origin based on weir counts at Willow Creek. The effects of these artificial propagation programs on the ESU's productivity and spatial structure are limited. Only three rivers have hatchery populations, and natural populations are depressed throughout the range of the ESU. The effects of these hatchery programs on the ESU's diversity are likely also limited. Natural-origin fish have been incorporated into the broodstock, but the proportion of natural fish incorporated into the broodstock is unknown. The SHIEER concluded that the three artificial propagation programs in the ESU collectively provide a beneficial effect to the ESU's abundance, but neutral or uncertain effects to the ESU's productivity, spatial structure, and diversity. Informed by the BRT's findings (NMFS 2003b) and the SHIEER's assessment of the effects of artificial propagation programs on the viability of the ESU (NMFS 2004b), the workshop participants concluded that the Southern Oregon/Northern California Coast coho ESU in-total is "likely to become endangered in the foreseeable future." There were no dissenting views expressed concerning the extinction risk assessment of the Southern Oregon/Northern California Coast coho ESU in-total.

Table 4.13. Summary of the Artificial Propagation Evaluation Workshop's findings for the Southern Oregon/Northern California Coast coho ESU.

| **VSP Criterion** | **Collective Impact of within-ESU Hatchery Programs on** |
|---|---|

| | **the VSP Risks for the Entire ESU** |
|---|---|
| Abundance | Decreased risk |
| Productivity | Neutral or uncertain effect |
| Spatial structure | Neutral or uncertain effect |
| Diversity | Neutral or uncertain effect |
| **Extinction risk for the ESU in-total:** | **Artificial propagation programs do not substantially change the BRT's assessment of the ESU's extinction risk** ***The Southern Oregon/Northern California Coast coho ESU is likely to become endangered within the foreseeable future throughout all or a significant portion of its range.*** |

4.14 Upper Willamette River chinook ESU

The strong majority opinion of the BRT was that the naturally spawned component of the Upper Willamette River chinook ESU is "likely to become endangered within the foreseeable future," with a minority opinion that the ESU is "in danger of extinction." The BRT found moderately high risks for all VSP categories.

The SHIEER concluded that there are seven artificial propagation programs that are no more than moderately diverged from the local natural populations in the ESU. These seven hatchery programs are considered part of the Upper Willamette River chinook ESU (Table 2): the McKenzie River Hatchery (Oregon Department of Fish and Wildlife (ODFW) stock # 24), Marion Forks/North Fork Santiam River (ODFW stock # 21), South Santiam Hatchery (ODFW stock # 23) in the South Fork Santiam River, South Santiam Hatchery in the Calapooia River, South Santiam Hatchery in the Mollala River, Willamette Hatchery (ODFW stock # 22), and Clackamas hatchery (ODFW stock # 19) spring-run chinook hatchery programs. There were no dissenting opinions offered by the workshop attendees regarding the ESU membership of the above listed hatchery programs.

All of the within-ESU hatchery programs are funded to mitigate for lost or degraded habitat and produce fish for harvest purposes. An increasing proportion of hatchery-origin returns has contributed to increases in the ESU's total abundance. However, it is unclear whether these returning hatchery and natural fish actually survive overwintering to spawn. Estimates of pre-spawning mortality indicate that a high proportion (>70%) of spring chinook die before spawning in most ESU populations. In recent years, hatchery fish have been used to reintroduce spring chinook back into historical habitats above impassible dams (e.g., in the South Santiam, North Santiam, and McKenzie Rivers) slightly decreasing risks to the ESU's spatial structure. Within-ESU hatchery fish exhibit differing life-history characteristics from natural ESU fish. High proportions of hatchery-origin natural spawners in remaining natural production areas (i.e., in the Clackamas and McKenzie Rivers) may thereby have negative impacts on within and among population genetic and life-history diversity. The SHIEER concluded that the seven artificial propagation programs in the ESU collectively provide a slight beneficial effect to the ESU's abundance and spatial structure, but neutral or uncertain effects to the ESU's productivity and diversity. Informed by the BRT's findings (NMFS 2003b) and the SHIEER's assessment of the effects of artificial propagation programs on the viability of the ESU (NMFS 2004b), the workshop participants concluded that the Upper Willamette River chinook ESU in-total is "likely to become endangered in the foreseeable future." There were no dissenting views expressed concerning the extinction risk assessment of the Upper Willamette River chinook ESU in-total.

Table 4.14. Summary of the Artificial Propagation Evaluation Workshop's findings for the Upper Willamette River chinook ESU.

| **VSP Criterion** | **Collective Impact of within-ESU Hatchery Programs on the VSP Risks for the Entire ESU** |
|---|---|
| Abundance | Slightly decreased risk |
| Productivity | Neutral or uncertain effect |
| Spatial structure | Slightly decreased risk |
| Diversity | Neutral or uncertain effect |
| **Extinction risk for the ESU in-total:** | **Artificial propagation programs do not substantially change the BRT's assessment of the ESU's extinction risk** ***The Willamette River chinook ESU is likely to become endangered within the foreseeable future throughout all or a significant portion of its range.*** |

### 4.15 Columbia River chum ESU

The majority opinion of the BRT was that the naturally spawned component of the Columbia River chum ESU is "likely to become endangered within the foreseeable future," with a minority opinion that it is "in danger of extinction." The BRT found high risks for each of the VSP categories, particularly for the ESU's spatial structure and diversity.

The SHIEER concluded that there are three artificial propagation programs that are no more than moderately diverged from the local natural populations in the ESU. These hatchery programs are considered part of the Columbia River chum ESU (Table 2): the Chinook River (Sea Resources Hatchery), Grays River, and Washougal River/Duncan Creek chum hatchery programs. There were no dissenting opinions offered by the workshop attendees regarding the ESU membership of the above listed hatchery programs.

The hatchery programs included in the ESU are conservation programs designed to support natural production. The Washougal Hatchery artificial propagation program provides artificially propagated chum salmon for re-introduction into recently restored habitat in Duncan Creek, Washington. This program also provides a safety-net for the naturally spawning population in the mainstem Columbia River below Bonneville Dam, which can access only a portion of spawning habitat during low flow conditions. The other two programs are designed to augment natural production in the Grays River, and the Chinook River in Washington. All these programs use naturally produced adults for broodstock. These programs were only recently established (1998-2002), with the first hatchery-origin chum returning in 2002.

The Columbia River chum hatchery programs have only recently been initiated, and are beginning to provide benefits to the ESU's abundance. The contribution of the within-ESU hatchery programs to the productivity of the ESU in-total is uncertain. The Sea Resources and Washougal Hatchery programs have begun to provide benefits to the ESU's spatial structure through reintroductions of chum salmon into restored habitats in the Chinook River and Duncan Creek, respectively. These three programs have a neutral effect on the ESU's diversity. The SHIEER concluded that the three artificial propagation programs in the ESU collectively provide a slight beneficial effect to the ESU's abundance, but neutral or uncertain effects to the ESU's productivity, spatial structure, and diversity. Informed by the BRT's findings (NMFS 2003b) and the SHIEER's assessment of the effects of artificial propagation programs on the viability of the ESU (NMFS 2004b), the workshop participants concluded that the Columbia River chum ESU in-total is "likely to become endangered in the foreseeable future." There were no dissenting views expressed concerning the extinction risk assessment of the Columbia River chum ESU in-total.

Table 4.15. Summary of the Artificial Propagation Evaluation Workshop's findings for the Upper Willamette River chinook ESU.

| **VSP Criterion** | **Collective Impact of within-ESU Hatchery Programs on the VSP Risks for the Entire ESU** |
|---|---|
| Abundance | Slightly decreased risk |
| Productivity | Neutral or uncertain effect |
| Spatial structure | Neutral or uncertain effect |
| Diversity | Neutral or uncertain effect |
| **Extinction risk for the ESU in-total:** | **Artificial propagation programs do not substantially change the BRT's assessment of the ESU's extinction risk** ***The Columbia River chum ESU is likely to become endangered within the foreseeable future throughout all or a significant portion of its range.*** |

4.16 Lower Columbia River O. mykiss ESU

The majority opinion of the BRT was that the naturally spawned component of the Lower Columbia River O. mykiss ESU is "likely to become endangered within the foreseeable future," with a minority opinion that the ESU is "not in danger of extinction or likely to become endangered within the foreseeable future." The BRT found moderate risks in each of the VSP categories.

The SHIEER concluded that there are ten artificial propagation programs that are no more than moderately diverged from the local natural populations in the ESU. These ten hatchery programs are considered part of the Lower Columbia River O. mykiss ESU (Table 2): the Cowlitz Trout Hatchery (in the Cispus, Upper Cowlitz, Lower Cowlitz, and Tilton Rivers), Kalama River Wild (winter- and summer-run), Clackamas Hatchery, Sandy Hatchery, and Hood River steelhead hatchery programs. There were no dissenting opinions offered by the workshop attendees regarding the ESU membership of the above listed hatchery programs.

All of the within-ESU hatchery programs are designed to produce fish for harvest, but several are also implemented to augment the natural spawning populations in the basins where the fish are released. Four of these programs are part of research activities to determine the effects of artificial propagation programs that use naturally produced steelhead for broodstock in an attempt to minimize the genetic effects of returning hatchery adults that spawn naturally. One of these programs, the Cowlitz River late-run winter steelhead program, is also producing fish for release into the upper Cowlitz River basin in an attempt to re-establish a natural spawning population above Cowlitz Falls Dam.

The hatchery programs have reduced risks to the ESU's abundance by increasing the ESU's total abundance and the abundance of fish spawning naturally in the ESU. The contribution of the within-ESU hatchery programs to the productivity of the ESU in-total is uncertain. It is also uncertain if reintroduced steelhead into the Upper Cowlitz River will be viable in the foreseeable future, as outmigrant survival appears to be quite low. As noted by the BRT, out-of-ESU hatchery programs have negatively impacted the ESU's productivity. The within-ESU hatchery programs provide a slight decrease in risks to the ESU's spatial structure, principally through the re-introduction of steelhead into the Upper Cowlitz River basin. The eventual success of these reintroduction efforts, however, is uncertain. Harvest augmentation programs that have instituted locally-adapted natural broodstock protocols (e.g., the Sandy, Clackamas, Kalama, and Hood River programs) have reduced adverse genetic effects and benefited the ESU's diversity. Non-ESU hatchery programs in the Lower Columbia River remain a threat to the ESU's diversity. Workshop observers from the BRT noted that the BRT had considered the adverse impacts of non-ESU hatchery fish in its extinction risk assessments. The SHIEER concluded that the ten artificial propagation programs in the ESU collectively provide slight beneficial effects to the ESU's abundance, spatial structure, and diversity, but uncertain effects to the ESU's productivity. Informed by the BRT's findings (NMFS 2003b) and the SHIEER's assessment of the effects of artificial propagation programs on the viability of the ESU (NMFS 2004b), the workshop participants concluded that the Lower Columbia River O. mykiss ESU in-total is "likely to become endangered in the foreseeable future." There were no dissenting views expressed concerning the extinction risk assessment of the Lower Columbia River O. mykiss ESU in-total.

Table 4.16. Summary of the Artificial Propagation Evaluation Workshop's findings for the Lower Columbia River O. mykiss ESU.

| **VSP Criterion** | **Collective Impact of within-ESU Hatchery Programs on the VSP Risks for the Entire ESU** |
|---|---|
| Abundance | Slightly decreased risk |
| Productivity | Neutral or uncertain effect |
| Spatial structure | Slightly decreased risk |
| Diversity | Slightly decreased risk |
| **Extinction risk for the ESU in-total:** | **Artificial propagation programs do not substantially change the BRT's assessment of the ESU's extinction risk** ***The Lower Columbia River O. mykiss ESU is likely to*** |

| | |
|---|---|
| | ***become endangered within the foreseeable future throughout all or a significant portion of its range.*** |

4.17 Lower Columbia River chinook ESU

The majority opinion of the BRT was that the naturally spawned component of the Lower Columbia River chinook ESU is "likely to become endangered within the foreseeable future," with the minority being split between "in danger of extinction" and "not in danger of extinction or likely to become endangered within the foreseeable future." The BRT found moderately high risk for all VSP categories.

The SHIEER concluded that there are seventeen artificial propagation programs that are no more than moderately diverged from the local natural populations in the ESU. These hatchery programs are considered part of the Lower Columbia River chinook ESU (Table 2): the Sea Resources Tule chinook Program, Big Creek Tule chinook Program, Astoria High School (STEP) Tule chinook Program, Warrenton High School (STEP) Tule chinook Program, Elochoman River Tule chinook Program, Cowlitz Tule Chinook Program, North Fork Toutle Tule chinook Program, Kalama Tule chinook Program, Washougal River Tule chinook Program, Spring Creek NFH Tule chinook Program, Cowlitz spring chinook Program in the Upper Cowlitz River and the Cispus River, Friends of the Cowlitz spring chinook Program, Kalama River spring chinook Program, Lewis River spring chinook Program, Fish First spring chinook Program, and the Sandy River Hatchery (ODFW stock #11) chinook hatchery programs. There were no dissenting opinions offered by the workshop attendees regarding the ESU membership of the above listed hatchery programs.

All of the within-ESU hatchery programs are designed to produce fish for harvest, with 3 of these programs also being implemented to augment the naturally spawning populations in the basins where the fish are released. These three programs integrate naturally produced spring chinook salmon into the broodstock in an attempt to minimize the genetic effects of returning hatchery adults that spawn naturally.

Hatchery programs have increased total returns and numbers of fish spawning naturally, thus reducing risks to the ESU's abundance. Although these hatchery programs have been successful at producing substantial numbers of fish, their effect on the productivity of the ESU in-total is uncertain. Additionally, the high levels of hatchery production in this ESU pose potential genetic and ecological risks to the ESU, and confound the monitoring and evaluation of abundance trends and productivity. The Cowlitz River spring chinook salmon program produces parr for release into the upper Cowlitz River basin in an attempt to re-establish a naturally spawning population above Cowlitz Falls Dam. Such reintroduction efforts increase the ESU's spatial distribution into historical habitats, and slightly reduce risks to the ESU's spatial structure. The few programs that regularly integrate natural fish into the broodstock may help preserve genetic diversity within the ESU. However, the majority of hatchery programs in the ESU have not converted to the regular incorporation of natural broodstock, thus limiting this risk reducing feature at the ESU scale. Past and ongoing transfers of broodstock among hatchery programs in different basins represent a risk to within and among population diversity.

The SHIEER concluded that the seventeen artificial propagation programs in the

ESU collectively provide a slight beneficial effect to the ESU's abundance, spatial structure, and diversity, but uncertain effects to the ESU's productivity. Informed by the BRT's findings (NMFS 2003b) and the SHIEER's assessment of the effects of artificial propagation programs on the viability of the ESU (NMFS 2004b), the workshop participants concluded that the Lower Columbia River chinook ESU in-total is "likely to become endangered in the foreseeable future." There were no dissenting views expressed concerning the extinction risk assessment of the Lower Columbia River chinook ESU in-total.

Table 4.17. Summary of the Artificial Propagation Evaluation Workshop's findings for the Lower Columbia River chinook ESU.

| VSP Criterion | Collective Impact of within-ESU Hatchery Programs on the VSP Risks for the Entire ESU |
|---|---|
| Abundance | Slightly decreased risk |
| Productivity | Neutral or uncertain effect |
| Spatial structure | Slightly decreased risk |
| Diversity | Slightly decreased risk |
| **Extinction risk for the ESU in-total:** | **Artificial propagation programs do not substantially change the BRT's assessment of the ESU's extinction risk** ***The Lower Columbia River chinook ESU is likely to become endangered within the foreseeable future throughout all or a significant portion of its range.*** |

4.18 Upper Columbia River O. mykiss ESU

The slight majority BRT opinion concerning the naturally spawned component of the Upper Columbia River O. mykiss ESU was in the "in danger of extinction" category, and the minority opinion was that the ESU is "likely to become endangered within the foreseeable future." The BRT found high risk for the productivity VSP category, with comparatively lower risk for the abundance, diversity, and spatial structure categories.

The SHIEER concluded that there are six artificial propagation programs that are no more than moderately diverged from the local natural populations in the ESU. These hatchery programs are considered part of the Upper Columbia River O. mykiss ESU (Table 2): the Wenatchee River, Wells Hatchery (in the Methow and Okanogan Rivers), Winthrop NFH, Omak Creek, and the Ringold steelhead hatchery programs. There were no dissenting opinions offered by the workshop attendees regarding the ESU membership of the above listed hatchery programs.

The within-ESU hatchery programs are intended to contribute to the recovery of the ESU by increasing the abundance of natural spawners, increasing spatial distribution, and improving local adaptation and diversity (particularly with respect to the Wenatchee River steelhead). Research projects to investigate the spawner productivity of hatchery-reared fish are being developed. Some of the hatchery-reared steelhead adults that return to the basin may be in excess of spawning population needs in years of high survival conditions, potentially posing a risk to the naturally spawned populations in the ESU.

The artificial propagation programs included in this ESU adhere to strict protocols for the collection, rearing, maintenance, and mating of the captive brood populations. The programs include extensive monitoring and evaluation efforts to continually evaluate the extent and implications of any genetic and behavioral differences that might emerge between the hatchery and natural stocks. Genetic evidence suggests that these programs remain closely related to the naturally-spawned populations and maintain local genetic distinctiveness of populations within the ESU. HCPs and binding mitigation agreements ensure that these programs will have secure funding and will continue into the future. These hatchery programs have undergone ESA Section 7 consultation to ensure that they do not jeopardize the recovery of the ESU, and they have received ESA Sec. 10 permits for production though 2007. Annual reports and other specific information reporting requirements are utilized to ensure that the terms and conditions as specified by NMFS are followed. These programs, through adherence to best professional practices, have not experienced disease outbreaks or other catastrophic losses.

The within-ESU hatchery programs substantially increase total ESU returns, particularly in the Methow basin where hatchery-origin fish comprise on average 92% of all returns. The contribution of hatchery programs to the abundance of naturally spawning fish is uncertain. The contribution of the within-ESU hatchery programs to the productivity of the ESU in-total is uncertain. However, several workshop participants noted that large numbers of hatchery-origin steelhead in excess of broodstock needs and what the available spawning habitat can support may decrease the ESU's productivity in-total. With increases in the ESU's abundance in recent years, naturally spawning hatchery-origin fish have expanded the spawning areas being utilized. Since 1996 efforts are being undertaken to establish the Wenatchee basin programs separately from the Wells steelhead hatchery program. These efforts are expected to increase the ESU's diversity over time. There is concern that the high proportion of Wells hatchery steelhead spawning naturally in the Methow and Okanogan basin may pose risks to the ESU's diversity by decreasing local adaptation. The Omak Creek program, although small in size, likely will increase population diversity over time. There has been concern that the early spawning components of the Methow and Wenatchee hatchery programs may represent a risk to the ESU's diversity. One workshop observer from the BRT suggested that the earlier run-timing of these programs may be genetically based, representing a risk to the ESU's diversity. The recent transfer of these early-run components to the Ringold Hatchery on the mainstem Columbia River minimize any potential risks to the diversity of the tributary populations, while establishing a genetic reserve on the mainstem Columbia River.

The SHIEER concluded that the six artificial propagation programs in the ESU collectively provide beneficial effects to the ESU's abundance and spatial structure, but neutral or uncertain effects to the ESU's productivity and diversity. Informed by the BRT's findings (NMFS 2003b) and the SHIEER's assessment of the effects of artificial propagation programs on the viability of the ESU (NMFS 2004b), the workshop participants concluded that the Upper Columbia River O. mykiss ESU in-total is "likely to become endangered in the foreseeable future." One workshop participant noted that the ESU's diversity was the principal VSP risk factor in BRT's extinction risk assessment of "in danger of extinction". The participant questioned why the other participants assessed a lower level of extinction risk although they concluded that the within-ESU hatchery programs have an uncertain effect on the ESU's productivity. A workshop observer from the BRT pointed out that the BRT's extinction risk assessment was fairly evenly split between the "in danger of extinction" and "likely to become endangered in the foreseeable future" categories. Given the close call in assessing the ESU's extinction risk, it was reasonable that the benefits provided by the artificial propagation programs to ESU's abundance and spatial structure could mitigate the immediacy of the ESU's extinction risk. There were no other dissenting views offered concerning the extinction risk of the Upper Columbia River O. mykiss ESU in-total.

Table 4.18. Summary of the Artificial Propagation Evaluation Workshop's findings for the Upper Columbia River O. mykiss ESU.

| **VSP Criterion** | **Collective Impact of within-ESU Hatchery Programs on the VSP Risks for the Entire ESU** |
|---|---|
| Abundance | Decreased risk |
| Productivity | Neutral or uncertain effect |
| Spatial structure | Decreased risk |
| Diversity | Neutral or uncertain effect |
| **Extinction risk for the ESU in-total:** | **Artificial propagation programs reduce the immediacy of the extinction risk assessed by the BRT for the natural populations in the ESU.**<br>***The Upper Columbia River O. mykiss ESU is likely to become endangered within the foreseeable future throughout all or a significant portion of its range.*** |

4.19 Snake River fall-run chinook ESU

The majority opinion of the BRT was that the naturally spawned component of the Snake River fall-run chinook ESU is "likely to become endangered within the foreseeable future." The minority opinion assessed the ESU's extinction risk as "in danger of extinction," although a slight minority fell in the "not in danger of extinction or likely to become endangered within the foreseeable future" category. The BRT found moderately high risk for all VSP categories.

The SHIEER concluded that there are four artificial propagation programs that are no more than moderately diverged from the local natural populations in the ESU. These four hatchery programs are considered part of the Snake River fall-run chinook ESU (Table 2): : the Lyons Ferry Hatchery, Fall Chinook Acclimation Ponds Program, Nez Perce Tribal Hatchery, and Oxbow Hatchery fall-run chinook hatchery programs. There were no dissenting opinions offered by the workshop attendees regarding the ESU membership of the above listed hatchery programs.

There are four artificial propagation programs producing Snake River fall chinook salmon in the Snake River basin, all based on the Lyons Ferry Hatchery stock. When naturally spawning fall chinook declined to fewer than 100 fish in 1991, most of the genetic legacy of this ESU was preserved in the Lyons Ferry Hatchery broodstock (NMFS 1991c). These four hatchery programs are managed to enhance listed Snake

River fall-run chinook salmon and presently include the Lyons Ferry Hatchery, Fall Chinook Acclimation Ponds Program, Nez Perce Tribal Hatchery, and Oxbow Hatchery (an Idaho Power Company mitigation hatchery). These existing programs release fish into the mainstem Snake River and Clearwater River which represent the majority of the remaining habitat available to this ESU.

These hatchery programs have contributed to the recent substantial increases in the ESU's total abundance, including both natural-origin and hatchery-origin ESU components. Spawning escapement has increased to several thousand adults (from a few hundred in the early 1990's) due in large part to increased releases from these hatchery programs. Workshop participants also pointed out that improved ocean conditions likely also contributed to these increases. These hatchery programs collectively have had a beneficial effect on the ESU's abundance in recent years. The BRT noted, however, that the large but uncertain fraction of naturally spawning hatchery fish complicates assessments of the ESU's abundance and productivity. The contribution of the within-ESU hatchery programs to the productivity of the ESU in-total is uncertain. As the ESU's abundance has increased in recent years, ESU spatial distribution has increased, although the ESU is still limited to a single population in an area representing approximately 15% of its historical range. The extant distribution represent marginal habitat, with flow, temperature regime, and dissolved oxygen conditions significantly affected by the hydropower system. Although the ESU likely historically consisted of a single independent population, it was most likely composed of diverse production centers. Additionally, the broodstock collection practices employed pose risks to the ESU's spatial structure and diversity. Nonetheless, the Snake River fall-run chinook hatchery programs have contributed to a slight in risk to the ESU's spatial distribution. The Lyons Ferry stock has preserved genetic diversity during critically low years of abundance. However, the ESU-wide use of a single hatchery broodstock may pose long-term genetic risks, and may limit adaptation to different habitat areas. Release strategies practiced by the within-ESU hatchery programs (e.g., extended captivity for about 15% of the fish before release) are in conflict with the Snake River fall-run chinook life history, and may compromise the ESU's diversity. Additionally, several workshop participants and observers from the BRT expressed concern regarding the long-term diversity of the ESU. The single extant population comprising the ESU exists in a greatly altered environment in the tailrace of the Hells Canyon hydropower system. Fish in the ESU appear to be adapting their life-history characteristics to these altered conditions. Although this adaptation may improve the reproductive fitness of the ESU in such a modified environment, it may also result over the long-term in an ESU with very different life-history characteristics than the evolutionary legacy of the ESU.

The SHIEER concluded that the four artificial propagation programs in the ESU collectively provide a beneficial effect to the ESU's abundance and diversity, a slight benefit to the ESU's spatial structure, but neutral or uncertain effects to the ESU's productivity. Informed by the BRT's findings (NMFS 2003b) and the SHIEER's assessment of the effects of artificial propagation programs on the viability of the ESU (NMFS 2004b), the workshop participants concluded that the Snake River fall-run chinook ESU in-total is "likely to become endangered in the foreseeable future." Several workshop participants and observers from the BRT were concerned that the benefits attributable to artificial propagation in the ESU were already considered by the BRT.

They were concerned that the SHIEER's and the workshops findings might include a "double counting" of benefits from within-ESU hatchery programs. That said, the workshop finding was that the artificial propagation programs did not mitigate the BRT's assessment of the ESU's extinction risk. There were no dissenting views expressed concerning the extinction risk assessment of the Snake River fall-run chinook ESU in-total.

Table 4.19. Summary of the Artificial Propagation Evaluation Workshop's findings for the Snake River fall-run chinook ESU.

| **VSP Criterion** | **Collective Impact of within-ESU Hatchery Programs on the VSP Risks for the Entire ESU** |
|---|---|
| Abundance | Decreased risk |
| Productivity | Neutral or uncertain effect |
| Spatial structure | Slightly decreased risk |
| Diversity | Decreased risk |
| **Extinction risk for the ESU in-total:** | **Artificial propagation programs do not substantially change the BRT's assessment of the ESU's extinction risk** ***The Snake River fall-run chinook ESU is likely to become endangered within the foreseeable future throughout all or a significant portion of its range.*** |

4.20 Snake River sockeye ESU

The BRT unanimously concluded that the Snake River sockeye ESU is "in danger of extinction," finding extremely high risks for each of the four VSP categories.

The SHIEER concluded that there is one artificial propagation programs that is no more than moderately diverged from the local natural populations, and considered to be part of the Snake River sockeye ESU: the Redfish Lake Captive Propagation program. There were no dissenting opinions offered by the workshop attendees regarding the ESU membership of the above listed hatchery program.

The Redfish Lake sockeye salmon stock was originally founded by collecting the entire anadromous adult return of 16 fish between 1990 and 1997, the collection of a small number of residual sockeye salmon, and the collection of a few hundred smolts migrating from Redfish Lake. These fish were put into a Captive Broodstock program as an emergency measure to prevent extinction of this ESU. Since 1997, nearly 400 hatchery-origin anadromous sockeye adults have returned to the Stanley Basin from juveniles released by the program. Redfish Lake sockeye salmon have also been reintroduced into Alturas and Pettit Lakes using progeny from the captive broodstock program. The captive broodstock program presently consists of several hundred fish of different year classes maintained at facilities in Eagle (Idaho) and Manchester (Washington).

The workshop attendees noted that the Captive Broodstock Program has likely prevented the extinction of the ESU. This program has increased the total number of anadromous adults, attempted to increase the number of lakes in which sockeye salmon are present in the upper Salmon River (Stanley Basin), and preserved what genetic diversity remains in the ESU. Although the program has increased the number of anadromous adults in some years, it has yet to produce consistent returns. The majority of the ESU now resides in the captive program composed of only a few hundred fish. The long-term effects of captive rearing are unknown. The SHIEER concluded that the Redfish Lake captive propagation program provides neutral or uncertain effects to the ESU's abundance, productivity, spatial structure, and diversity. Informed by the BRT's findings (NMFS 2003b) and the SHIEER's assessment of the effects of artificial propagation programs on the viability of the ESU (NMFS 2004b), the workshop participants concluded that the Snake River sockeye ESU in-total is "in danger of extinction." There were no dissenting views expressed concerning the extinction risk assessment of the Snake River sockeye ESU in-total.

Table 4.20. Summary of the Artificial Propagation Evaluation Workshop's findings for the Snake River sockeye ESU.

| VSP Criterion | Collective Impact of within-ESU Hatchery Programs on the VSP Risks for the Entire ESU |
|---|---|
| Abundance | Neutral or uncertain effect |
| Productivity | Neutral or uncertain effect |
| Spatial structure | Neutral or uncertain effect |
| Diversity | Neutral or uncertain effect |
| **Extinction risk for the ESU in-total:** | **Artificial propagation programs do not substantially change the BRT's assessment of the ESU's extinction risk** ***The Snake River sockeye ESU is in danger of extinction throughout all or a significant portion of its range.*** |

4.21 Snake River spring/summer-run chinook ESU

The majority opinion of the BRT was that the naturally spawned component of the Snake River spring/summer-run chinook ESU is "likely to become endangered within the foreseeable future." The minority opinion assessed the ESU's extinction risk as "in danger of extinction," although a slight minority concluded that the ESU is "not in danger of extinction or likely to become endangered within the foreseeable future". The BRT found moderately high risk for the abundance and productivity VSP criteria, and comparatively lower risk for spatial structure and diversity.

The SHIEER concluded that there are fifteen artificial propagation programs that are no more than moderately diverged from the local natural populations in the ESU. These hatchery programs are considered part of the Snake River spring/summer-run chinook ESU (Table 2): the Tucannon River conventional Hatchery, Tucannon River Captive Broodstock Program, Lostine River, Catherine Creek, Lookingglass Hatchery Reintroduction Program (Catherine Creek stock), Upper Grande Ronde, Imnaha River, Big Sheep Creek, McCall Hatchery, Johnson Creek Artificial Propagation Enhancement, Lemhi River Captive Rearing Experiment, Pahsimeroi Hatchery, East Fork Captive

Rearing Experiment, West Fork Yankee Fork Captive Rearing Experiment, and the Sawtooth Hatchery spring/summer-run chinook hatchery programs. There were no dissenting opinions offered by the workshop attendees regarding the ESU membership of the above listed hatchery programs.

The within-ESU hatchery programs are managed to enhance listed natural populations, including the use of captive broodstock hatcheries in the upper Salmon River, Lemhi River, East Fork Salmon River, and Yankee Fork populations. These enhancement programs all use broodstocks founded from the local native populations. Currently, the use of non-ESU broodstock sources is restricted to Little Salmon/Rapid River (lower Salmon River tributary), mainstem Snake River at Hells Canyon, and the Clearwater River. These non-ESU programs appear to be isolated from natural production areas and are thought to have little negative impact on this ESU.

Overall, these hatchery programs have contributed to the increases in the ESU's total abundance and in the number of natural spawners observed in recent years. The contribution of the within-ESU hatchery programs to the productivity of the ESU in-total is uncertain. Some reintroduction and outplanting of hatchery fish above barriers and into vacant habitat has occurred, providing a slight benefit to the ESU's spatial structure. All of the within-ESU hatchery stocks are derived from local natural populations and employ management practices designed to preserve genetic diversity. The Grande Ronde Captive Broodstock programs likely have prevented the extirpation of the local natural populations. Additionally, hatchery releases are managed to maintain wild fish reserves in the ESU in an effort to preserve natural local adaptation and genetic variability. The SHIEER concluded that the fifteen artificial propagation programs in the ESU collectively provide a beneficial effect to the ESU's abundance, spatial structure, and diversity, but neutral or uncertain effects to the ESU's productivity. One workshop observer questioned whether the benefits attributable to the within-ESU artificial propagation programs had already been considered by the BRT. Regardless, the SHIEER and the workshop participants concluded that the consideration of the benefits of artificial propagation did not alter the BRT's extinction risk assessment. Informed by the BRT's findings (NMFS 2003b) and the SHIEER's assessment of the effects of artificial propagation programs on the viability of the ESU (NMFS 2004b), the workshop participants concluded that the Snake River spring/summer-run chinook ESU in-total is "likely to become endangered in the foreseeable future." There were no dissenting views expressed concerning the extinction risk assessment of the ESU in-total.

Table 4.21. Summary of the Artificial Propagation Evaluation Workshop's findings for the Snake River spring/summer-run chinook ESU.

| **VSP Criterion** | **Collective Impact of within-ESU Hatchery Programs on the VSP Risks for the Entire ESU** |
|---|---|
| Abundance | Decreased Risk |
| Productivity | Neutral or uncertain effect |
| Spatial structure | Decreased Risk |
| Diversity | Decreased Risk |
| **Extinction risk for the ESU in-total:** | **Artificial propagation programs do not substantially change the BRT's assessment of the ESU's extinction risk** |

| | |
|---|---|
| | ***The Snake River spring/summer-run chinook ESU is likely to become endangered within the foreseeable future throughout all or a significant portion of its range.*** |

4.22 Snake River Basin O. mykiss ESU

The majority opinion of the BRT was that the naturally spawned component of the Snake River Basin O. mykiss ESU is "likely to become endangered within the foreseeable future." The minority BRT opinion was split between the "in danger of extinction" and "not in danger of extinction or likely to become endangered within the foreseeable future" extinction risk categories. The BRT found moderate risk for the abundance, productivity, and diversity VSP categories, and comparatively lower risk in the spatial structure category.

The SHIEER concluded that there are six artificial propagation programs that are no more than moderately diverged from the local natural populations in the ESU. These six hatchery programs are considered part of the Snake River Basin O. mykiss ESU (Table 2): the Tucannon River, Dworshak NFH, Lolo Creek, North Fork Clearwater, East Fork Salmon River, and the Little Sheep Creek/Imnaha River Hatchery steelhead hatchery programs. There were no dissenting opinions offered by the workshop attendees regarding the ESU membership of the above listed hatchery programs.

The within-ESU artificial propagation enhancement efforts occur in the Imnaha River (Oregon), Tucannon River (Washington), East Fork Salmon River (Idaho, in the initial stages of broodstock development), and South Fork Clearwater River (Idaho). In addition, the Dworshak Hatchery acts as a gene bank to preserve the North Fork Clearwater River "B"-run steelhead population, which no longer has access to historical habitat due to construction of Dworshak Dam.

The Snake River Basin steelhead hatchery programs may be providing some limited benefits to the abundance of the local target natural populations, but only the Dworshak-based programs have appreciably benefited the number of total adult spawners. The Little Sheep Creek hatchery program is contributing to total abundance in the Imnaha River, but has not contributed to increased natural production. The Tucannon and East Fork Salmon River programs have only recently been initiated, and have yet to produce appreciable adult returns. The overall contribution of the hatchery programs in reducing risks to the ESU's abundance is small. The contribution of the within-ESU hatchery programs to the productivity of the ESU in-total is uncertain. Most returning Snake River Basin hatchery steelhead are collected at hatchery weirs or have access to unproductive mainstem habitats, limiting potential contributions to the productivity of the entire ESU. The artificial propagation programs affect only a small portion of the ESU's spatial distribution, and confer only slight benefits to the ESU's spatial structure. Large steelhead programs, not considered to be part of the ESU, occur in the mainstem Snake, Grande Ronde, and Salmon Rivers and may adversely affect the ESU's diversity. These out-of-ESU programs are currently undergoing review to determine the level of isolation between the natural and hatchery stocks and to define what reforms may be needed. The SHIEER concluded that the six artificial propagation programs in the ESU collectively provide a slight beneficial effect to the ESU's abundance and spatial structure, but neutral or uncertain effects to the ESU's productivity and diversity. Informed by the BRT's findings (NMFS 2003b) and the SHIEER's assessment of the effects of artificial propagation programs on the viability of the ESU (NMFS 2004b), the workshop participants concluded that the Snake River Basin O. mykiss ESU in-total is "likely to become endangered in the foreseeable future." There were no dissenting views expressed concerning the extinction risk assessment of the ESU in-total.

Table 4.22. Summary of the Artificial Propagation Evaluation Workshop's findings for the Snake River Basin O. mykiss ESU.

| **VSP Criterion** | **Collective Impact of within-ESU Hatchery Programs on the VSP Risks for the Entire ESU** |
|---|---|
| Abundance | Slightly decreased risk |
| Productivity | Neutral or uncertain effect |
| Spatial structure | Slightly decreased risk |
| Diversity | Neutral or uncertain effect |
| **Extinction risk for the ESU in-total:** | **Artificial propagation programs do not substantially change the BRT's assessment of the ESU's extinction risk** ***The Snake River Basin O. mykiss ESU is likely to become endangered within the foreseeable future throughout all or a significant portion of its range.*** |

### 4.23 Middle Columbia River O. mykiss ESU

The opinion of the BRT was closely divided between the "likely to become endangered within the foreseeable future" and "not in danger of extinction or likely to become endangered within the foreseeable future" extinction risk categories. The BRT found moderate risk in each of the VSP categories, with the greatest relative risk being attributed to the ESU's abundance.

The SHIEER concluded that there are seven artificial propagation programs that are no more than moderately diverged from the local natural populations in the ESU. These hatchery programs are considered part of the Middle Columbia River O. mykiss ESU (Table 2): the Touchet River Endemic, Yakima River Kelt Reconditioning Program (in Satus Creek, Toppenish Creek, Naches River, and Upper Yakima River), Umatilla River, and the Deschutes River steelhead hatchery programs. There were no dissenting opinions offered by the workshop attendees regarding the ESU membership of the above listed hatchery programs.

The within-ESU hatchery programs propagate steelhead in 3 of 16 ESU populations, and improve kelt (post-spawned steelhead) survival in one population. There are no artificial programs producing the winter-run life history in the Klickitat River and Fifteenmile Creek populations. All of the within-ESU hatchery programs are designed to produce fish for harvest, although two are also implemented to augment the natural spawning populations in the basins where the fish are released. The artificial propagation programs that produce these latter two hatchery stocks in the Umatilla River (Oregon) and the Touchet River (Washington) use naturally produced adults for broodstock. The remaining programs do not incorporate natural adults into the broodstock.

The within-ESU hatchery programs may provide a slight benefit to the ESU's abundance. Artificial propagation increases the ESU's total abundance, principally in the Umatilla and Deschutes Rivers. The kelt reconditioning efforts in the Yakima River does not augment natural abundance, but does benefit the survival of the natural populations. The Touchet River hatchery program has only recently been established, and its contribution to the ESU's viability is uncertain. The contribution of the within-ESU hatchery programs to the productivity of the three target populations, and the ESU in-total, is uncertain. The hatchery programs affect a small proportion of the ESU providing a negligible contribution to the ESU's spatial structure. Overall the impacts to the ESU's diversity are neutral. The Umatilla River program, through the incorporation of natural broodstock, likely limits adverse effects to population diversity. The Deschutes River hatchery program may be decreasing population diversity. The recently initiated Touchet River endemic program is attempting to reduce adverse effects to diversity through the elimination of out-of-ESU Lyons Ferry Hatchery steelhead stock. The SHIEER concluded that the seven artificial propagation programs in the ESU collectively provide a slight beneficial effect to the ESU's abundance, but neutral or uncertain effects to the ESU's productivity, spatial structure, and diversity. Informed by the BRT's findings (NMFS 2003b) and the SHIEER's assessment of the effects of artificial propagation programs on the viability of the ESU (NMFS 2004b), the workshop participants concluded that the Middle Columbia River O. mykiss ESU in-total is "likely to become endangered in the foreseeable future." There were no dissenting views expressed concerning the extinction risk assessment of the ESU in-total.

Table 4.23. Summary of the Artificial Propagation Evaluation Workshop's findings for the Middle Columbia River O. mykiss ESU.

| **VSP Criterion** | **Collective Impact of within-ESU Hatchery Programs on the VSP Risks for the Entire ESU** |
|---|---|
| Abundance | Slightly decreased risk |
| Productivity | Neutral or uncertain effect |
| Spatial structure | Neutral or uncertain effect |
| Diversity | Neutral or uncertain effect |
| **Extinction risk for the ESU in-total:** | **Artificial propagation programs do not substantially change the BRT's assessment of the ESU's extinction risk** ***The Middle Columbia River O. mykiss ESU is likely to become endangered within the foreseeable future throughout all or a significant portion of its range.*** |

Table 3. Summary of the Artificial Propagation Evaluation Workshop's findings for 23 Evolutionarily Significant Units of West Coast salmon and Oncorhynchus mykiss

| Evolutionarily Significant Unit (ESU) | Current ESA Status[1] | Biological Review Team's Majority Finding for ESU Extinction Risk[2] | Artificial Propagation Evaluation Workshop's Finding for ESU Extinction Risk | Number of Artificial Propagation Programs Included in the ESU |
|---|---|---|---|---|
| Snake River sockeye ESU………………………..……… | Endangered | In danger of extinction | In danger of extinction | 1 |
| Ozette Lake sockeye ESU……………………….….……… | Threatened | Likely to become endangered | Likely to become endangered | 2 |
| Sacramento River winter-run chinook ESU…………...…… | Endangered | In danger of extinction | In danger of extinction | 2 |
| California Coastal chinook ESU…………………….......... | Threatened | Likely to become endangered | Likely to become endangered | 7 |
| Upper Willamette River chinook ESU………………...…… | Threatened | Likely to become endangered | Likely to become endangered | 7 |
| Lower Columbia River chinook ESU…………................... | Threatened | Likely to become endangered | Likely to become endangered | 17 |
| Upper Columbia River spring-run chinook ESU…………... | Endangered. | In danger of extinction | In danger of extinction | 6 |
| Puget Sound chinook ESU……………………………..….... | Threatened. | Likely to become endangered | Likely to become endangered……… | 22 |
| Snake River fall-run chinook ESU……………………….... | Threatened | Likely to become endangered | Likely to become endangered | 4 |
| Snake River spring/summer-run chinook ESU…………..… | Threatened | Likely to become endangered | Likely to become endangered | 15 |
| Central California Coast coho ESU…………………..……. | Threatened | In danger of extinction | In danger of extinction | 4 |
| Southern Oregon/Northern California Coast coho ESU…... | Threatened | Likely to become endangered | Likely to become endangered | 3 |
| Oregon Coast coho ESU……………………………..…….. | Threatened | Likely to become endangered | Likely to become endangered | 5 |
| Lower Columbia River coho ESU……………………..…... | Candidate | In danger of extinction | Likely to become | 21 |

[1] Endangered Species Act (ESA)

[2] In evaluating an ESU's extinction risk, the Biological Review Team and the Artificial Propagation Evaluation Workshop determined whether an ESU is "in danger of extinction throughout all or a significant portion of its range," "likely to become endangered within the foreseeable future throughout all or a significant portion of its range,", or neither. The BRT's evaluations focused on the naturally spawned components in an ESU, while the Workshop focused on the extinction risk of an ESU in-total (including both hatchery and natural components).

| | | | | |
|---|---|---|---|---|
| | | | endangered | |
| Columbia River chum ESU…………………………...………. | Threatened | Likely to become endangered | Likely to become endangered | 3 |
| Hood Canal summer-run chum ESU………………...……... | Threatened | Likely to become endangered | Likely to become endangered | 8 |
| Central California Coast O. mykiss ESU…………………..…….. | Threatened | Likely to become endangered | Likely to become endangered | 2 |
| California Central Valley O. mykiss ESU…………..……… | Threatened | In danger of extinction | In danger of extinction | 2 |
| Northern California O. mykiss ESU…………..…………… | Threatened | Likely to become endangered | Likely to become endangered | 2 |
| Lower Columbia River O. mykiss ESU……………….…… | Threatened | Likely to become endangered | Likely to become endangered | 10 |
| Middle Columbia River O. mykiss ESU…..………………... | Threatened | Likely to become endangered | Likely to become endangered | 7 |
| Upper Columbia River O. mykiss ESU…………..………… | Endangered. | In danger of extinction | Likely to become endangered | 6 |
| Snake River Basin O. mykiss ESU…………….………... | Threatened | Likely to become endangered | Likely to become endangered | 6 |
| *ESUs that do not include artificial propagation programs* | | | | |
| Central Valley spring-run chinook ESU……………..……... | Threatened | Likely to become endangered | n/a | 0 |
| Southern California O. mykiss ESU…………….………… | Endangered | In danger of extinction | n/a | 0 |
| South-Central California Coast O. mykiss ESU……….…... | Threatened | Likely to become endangered | n/a | 0 |
| Upper Willamette River O. mykiss ESU……………...……... | Threatened | Likely to become endangered | n/a | 0 |

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